THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 42. Thursday, April 10, 1930. No. 712.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Forthcoming Events	263
Price and Profits	263
Industrial Co-operation	263
The Iron and Steel Industry Since the War	264
Iron and Steel Production	265
Random Shots	265
Steel Castings	266
Formation of Graphite	268
Some Technical Aspects of the Electric Steel Foundry	269
Some Recent Developments in German Foundry Practice	272
Standard Shatter Test for Foundry Coke	278
Iron and Steel Institute	278
Trade Talk	280
Personal	280
Obituary	280
Reports and Dividends	280
Company Meetings	280
Iron and Steel Markets	282
Scottish Launches	282

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1929-30:
Wesley Lambert,
J. Stone & Company, Limited, Deptford, London, S.E.14.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 26, Castlewood Road, Fulwood, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-upon-Tyne: F. Sanderson, 15, Handyside Arcade, Newcastle-upon-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitchurch, Glam.
Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: H. Winterton, Kelvinvale Mills, Maryhill, Glasgow.
Secretary: K. W. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.
The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 339).*

Forthcoming Events.

APRIL 12.

Swansea Technical College Metallurgical Society:—Annual meeting at Swansea.

Institute of British Foundrymen.

APRIL 18.

Sheffield and District Section:—Annual business meeting. "Cores and Core-Making," Paper by S. L. Grundy.

Price and Profits.

If Mr. J. M. Primrose has been reported correctly, he has made the rather startling statement that "most jobbing jobs were really repetition jobs, and could be made a much cheaper way than is usually done." When we read it we were impressed by the need of more data of the type indicated by Dr. Werner in Table I in his Paper which is printed elsewhere in this issue. This table shows the progressive economies realisable by the introduction of modern methods. In the case he cites a matter of 65 per cent. of the moulding time was saved. Apparently in Germany there is a realisation of such possibilities, and the preparation and dissemination, through co-operative enterprise, of a number of leaflets showing illustrated examples of the method and cost of making typical jobbing castings, does show that there is now little room left for regarding any single demand as a thing apart. Under modern conditions, the costing for jobbing should carry a large number of constants easily calculated, such as liquid metal, sand, handling, overheads. The most important variable being moulding time (after the provision of the pattern).

The frank exchange of moulding method plus tackle plus time by the various foundries would result in a better conception of the potentialities of foundry methods and machinery. Some foundries are far too prone to imagine that the processes carried out in their works are the only ones available. The compilation of data sheets for circulation amongst the foundries would create a tendency for orders to gravitate to the shops best able to handle them, and a natural rider to this movement would be the introduction of semi-automatic methods of fabrication.

Whilst but little facilities exist at the moment in Great Britain for exchange of views on methods, having direct industrial connections, we suggest that the various groups of foundries having trade associations or financial connections should originate a system of intelligent exchange of technical data on which costing is based. Scotland is complaining of English competition for lines of castings. It should be remembered that in a well-equipped shop a selling price of 20s. may yield a higher profit than 35s. in one employing old-fashioned methods. The 65 per cent. saving on moulding costs, referred to by Dr. Werner, can easily explain this, whilst much money can also be saved by scientific cupola management. Until bases for costing are made semi-public, there cannot and will not be any common denominator for the ascertaining of selling prices.

Industrial Co-operation.

The appreciated visit of Dr. Werner has left with the British foundry industry a clear impression of potentialities of large-scale close co-operation amongst competing firms. Eliminating the question of research, as this country possesses all the essential machinery for expansion to limits commensurate with the importance of the industry, there remain the questions of standardisation; personnel recruitment and vocational training; co-operative buying and selling; unified costing; authoritative representation to deal with the public services and taxation officers; and, above all, the creation of an advisory board to co-ordinate sectional effort, be it in the direction of a research, industrial, educational or political activity.

At the moment, the Institute of British Foundrymen is willingly and efficiently carrying out work which legitimately should be handled by an employers' federation covering the whole of the foundry industry. The work which the Institute does through the voluntary sacrifice of its individual members is more than commendable, and represents work which is insufficiently recognised by the employers as a whole, though sincerely appreciated by most of the individuals.

It is apparently easy to convene meetings of sections of the industry to consider ways and means of eliminating price-cutting and the raising of selling prices to allow of the profit-making stage being reached and maintained, but the leaders of these movements always tell us of the insuperable difficulties. We are reasonably sure that, if they would forget selling prices for a year or two and concentrate on the factors which govern them by giving service in the direction of proper cost-finding, rational operation of plant, and exercise co-operative representation for commercial questions other than selling prices, they would find the natural consequence of their endeavours would be the creation of economic sale prices. Dr. Werner stated that what a German foundry feared most was expulsion from the employers' federation. From this one cannot help but infer that services of the most valuable kind are to be derived from membership of an enterprising and enlightened employers' association.

XUM

The Iron and Steel Industry Since the War.

A REVIEW OF THE INDUSTRY IN GREAT BRITAIN AND FOREIGN COUNTRIES.

By M. S. Birkett, O.B.E.

(*Continued from page 252.*)

FRANCE.

The production of pig-iron in France in 1913 amounted to 5,207,307 tons, to which it had risen from 2,840,500 tons ten years earlier: the production of steel ingots and castings in 1913 amounted to 4,686,900 tons, having been 1,839,600 tons ten years previously. In both cases production was not much below capacity in 1913, and new building was in progress which was intended to increase capacity by about 1,000,000 tons each of pig-iron and steel. Of the total output in 1913, 3,560,000 tons of pig-iron and 2,530,000 tons of steel were produced in the East district, and 942,000 tons of pig and 1,164,000 tons of steel in the North: the greater part of these districts were overrun by the enemy during the war or were within range of his guns, so that France was deprived of a great proportion of her iron and steel-making capacity; to compensate for this in some degree new works were erected during the war in other parts of France with a capacity of 400,000 tons of pig-iron and 600,000 tons of steel. Under the Treaty of Versailles, Alsace-Lorraine was returned to France, and in this area there were produced in 1913, 3,870,000 tons of pig-iron, 2,286,000 tons of steel and 21,000,000 tons of iron ore. The works destroyed during the war have been rebuilt and extended and are naturally much more efficient than the pre-war works they have replaced.

Policy of the Banks.

France's output of pig-iron in 1918 amounted only to 1,306,500 tons; with the inclusion of Lorraine output in the following year rose to 2,412,100 tons. As the work of restoration proceeded, output rose to 3,453,800 tons in 1920, but suffered a slight set-back in the world slump of 1921; production in 1922 amounted to 5,228,600 tons, and was only slightly higher in 1923 owing to the dislocation of fuel supplies consequent upon the occupation of the Ruhr. Since 1923 progress has been substantial, and the highest total in France's history was attained in 1929, when 10,500,000 tons were produced. Before the war France hardly counted as an exporter of iron and steel products; in 1913 exports amounted to 629,700 tons. Practically half the output of Alsace-Lorraine was exported before the war, the other half being consumed in Germany and would thus now be reckoned as an export. As France's production increased, therefore, it was necessary to find a market for a considerable proportion of her production. This was rendered easier by the depreciating exchange, but France has not relied on this temporary stimulus alone; the banks have adopted an enterprising policy where foreign trade is concerned, while the State takes an active interest in foreign trade. One of the great metallurgical concerns has combined with others to form a foreign sales agency with a capital of 20 million francs and offices in the Argentine, Brazil, India, Spain, China and elsewhere, while another metallurgical and engineering concern has collaborated with an International Bank to form a holding company which has acquired interests in industrial and banking concerns in Czecho-Slovakia, Poland, Rumania, Hungary, Austria and elsewhere.

Exports of iron and steel, which amounted in 1913 to 629,700 tons, had risen by 1929 to about 4,200,000 tons; this latter figure, however, includes the Saar. Whereas Great Britain, even with the huge world demand of 1929, was operating at only 75 per cent. of her steel capacity, France operated throughout the major portion of the year very nearly at full capacity. Steel production last year, for instance, varied from an average of 790,000 tons per month by not more than 5 per cent. either way in any one month except February. This fact, combined with the other factors of low capital charges, lower social service costs, lower transport charges and lower capital costs, has made the French iron and steel industries very prosperous financially, and most of the big iron and steel concerns in recent years have earned substantial net profits; in addition to making adequate provision for amortisation, steel manufacturers have adopted a definite policy of re-investing a substantial proportion of their gross trading profits in the industry; the extension of plant has been a marked feature of post-war industrial development. In an endeavour to ensure that demand will keep pace with the extensions, French manufacturers have formed a Propaganda Association for the express purpose of advocating the increased use of steel. There is a tendency for wages to rise in France, and costs will also increase owing to the recent social legislation, but there is such a large margin between French and British costs that these increases are hardly likely to diminish France's competitive power *vis-à-vis* in this country.

BELGIUM.

Belgium's iron and steel industry is based historically on the ore which was found in the hilly region of the South, which was also covered with forests and well watered: fuel, ore and motive power were therefore present. On the exhaustion of the ore deposits and the denudation of the forests, the iron and steel industry began to grow in the valleys of the Sambre and the Meuse, principally in the neighbourhood of Charleroi and Liége, and based upon the coalfields of Liége and Hainaut. Belgium has practically no iron ore, but with the development of the Campine coalfield now uses much more of her own coal than formerly; for example, in 1929 of the total consumption of coke in blast furnaces, over 3,800,000 tons were Belgian coke and less than 200,000 tons foreign coke, and of the total consumption of coal used in the production of coke, rather more than half was native coal.

The production of pig-iron in Belgium by 1913 had reached 2,489,000 and of steel ingots and castings 2,467,000 tons. During the war most of the principal works in Belgium were systematically dismantled by the Germans and transported bodily to Germany. At the end of the war, therefore, most of the large works were incapable of producing iron and steel in any quantity until the plant had been reinstalled and modernised. The works have been reconstructed and are now very up to date. The effect of the rebuilding has been to augment very substantially the productive capacity of Belgium; while in 1919 only 250,600 tons of pig-iron and 333,600 tons of steel were produced, after a temporary set-back in 1921 this has gradually increased to 4,000,000 tons of pig-iron and 4,050,000 tons of steel in 1929. Such success has been attained, in spite of the necessity of importing nearly all the iron ore and a great part of the fuel supplies, owing to the presence of cheap and skilled labour, and the advantages obtained in the earlier years from depreciating exchanges. Belgium relies to a large extent on its foreign trade, and in 1922 a National Propaganda Committee was formed under the patronage of the Government for the purpose of co-ordinating all classes of propaganda for foreign countries, whether carried on by Government departments, municipalities, chambers of commerce, or in any other way. Since the war many missions have been sent out by Belgium with the object of studying the various markets and finding outlets for Belgium's trade. Belgium's biggest market for iron and steel is the United Kingdom, to which she exports great quantities of semi-finished steel for re-rolling into more finished forms. As in the case of France, the Belgian iron and steel industry is financially prosperous, and Belgium is also continually expanding her plant and equipment.

UNITED STATES.

By 1913 the United States had attained a production of 30,966,000 tons of pig-iron. By 1918 this had increased to 39,055,000 tons. Under the effect of post-war influences the 1918 output was not again reached until 1923, falling as low as 16,688,000 tons in 1921. Production between 1923 and 1928 fluctuated between 30 and 40 million tons, and in 1929 the highest output ever recorded (42,290,000 tons) was attained. This would have been higher but for the slump which occurred towards the end of the year. Steel production in the States in 1913 had reached 31,301,000 tons: the maximum war output occurred in 1917 at 45,061,000 tons. Steel production followed, roughly, the course of pig-iron production, and last year the record figure of 56,000,000 tons was reached.

It is well known that the bulk of the output of the American iron and steel industry is destined for home consumption: during the five years 1924-28 inclusive, for example, exports averaged only 5.3 per cent. of the total production. In 1929 exports declined to 4.8 per cent. of the total. The decline in general business activity at the end of last year, however, gave rise to serious misgivings as to whether the domestic market is likely to prove capable of absorbing steel tonnage on the scale which it has done in the past.

Steel Export Association.

The formation of the United States Steel Export Association in June, 1928, was interpreted by many as an indication that the policy of the American steel manufacturers in the future was likely to be more concerned with export trade than had been the case in the past. This association was established by America's two biggest steel producers—the United States Steel Trust and the Bethlehem Company—to co-ordinate their respective export-trade activities. It is generally considered that the main concern of the new association will be non-European countries, because the comparatively high production costs of the American iron and steel industry and the heavy freight charges will in general operate very strongly against exports on a large scale to Europe.

The formation of a joint association by the two most important steel producers in America for the purpose of developing their export trade is significant of the general movement towards amalgamation in the American heavy industry. America has been termed the home of Trusts, and, as was only to be expected, the heavy industry affords some outstanding examples of giant mergers. The U.S. Steel Corporation, for example, with an ingot capacity of some 24,500,000 tons, and the Bethlehem Steel Company, with an ingot capacity of 8,500,000 tons, are together responsible for approximately 55 per cent. of the total capacity of the American steel industry.

The most important feature of the development towards concentration in the American steel industry last year was the move to combine certain of the Independent steel companies into one unit. Negotiations with this end in view have now resulted in the formation of the new Republic Steel Combine, with an annual productive capacity of 2½ million tons of pig-iron and 5 million tons of crude steel per annum.

During recent years the American iron and steel industry has made substantial additions and improvements to plant and equipment. In 1929, for example, fourteen new open-hearth furnaces were built with an aggregate capacity of 1,135,000 tons per annum. For this year 47 new open-hearth furnaces have been planned, with a combined capacity of 4,690,000 tons per annum. The extension programme recently announced by the U.S. Steel Corporation is expected to involve a total expenditure of over £50 million, spread over the next three years; much of the work will represent an extension of additions and improvements which have been under way for some time, but in addition several new units will also be included.

CONCLUSION.

It has been demonstrated that many of the handicaps under which the British iron and steel industry has been operating during the post-war period are outside the control of the industry itself. In spite of these handicaps, British iron and steel makers have made substantial progress in their efforts to improve the competitive power of the industry. The most encouraging feature of the situation lies in the fact that, although steel-making capacity was increased, under pressure from the Government, by 50 per cent. during the war, present capacity is not substantially in excess of our export trade, plus domestic consumption. The great problem which steelmakers are facing at the present time is how to secure that a greater proportion of the home consumption shall be met from home production while at the same time developing the export trade. This they are doing in many ways. One of the most important is the movement towards amalgamations, which obviously provides possibilities of economies when the mergers are based on a financially secure foundation, and are between sound firms possessing the same class of raw materials and manufacturing similar products. An outstanding case of this kind was the amalgamation of Messrs. Dorman, Long & Company, Limited, and Messrs. Bolckow, Vaughan & Company, Limited, which took place at the end of last year; in recommending this merger to the shareholders, the chairman of Bolckow's—the Hon. Roland Kitson—stated that under the amalgamations it would be possible to pool their supplies of raw materials, and instead of running two ironstone mines, for instance, at 5,000 tons a week, to run one at 10,000 tons a week, and effect a saving of the order of 1s. per ton on ironstone or 3s. per ton on pig-iron; there were also economies to be expected in the stock of rolls which had to be kept; in the use of fuel; and in many other ways.

Actual amalgamations, or working arrangements, have also been made between the heavy steel branches of Guest, Keen & Nettlefolds, Limited, and Baldwins, Limited, and between David Colville & Sons, Limited, and Wm. Beardmore & Company, Limited; and the latest proposal is that relating to the Lancashire firms of Partington, the Wigan Coal & Iron Company, Limited, and Messrs. Pearson & Knowles, together with their associated undertakings. The comprehensive rationalisation of the English Steel Corporation is well known. Combinations on the scale existing in America and Germany are, of course, out of the question, first because the total volume of production in the United Kingdom is so much smaller, and, secondly, because the industry is not so concentrated as in America and Germany. Whereas in Germany, for instance, the Ruhr district is responsible for 80 per cent. of the country's output, in Great Britain no single district produces more than 30 per cent. of the total pig-iron output or more than 25 per cent. of the total output of steel. In addition to the amalgamation of individual companies, the co-operation of producers within the industry has been developed in many other ways.

On September 1, 1927, the British steelmakers revived the "rebate" scheme which had been adopted in 1911 in consequence of the determined onslaught which Germany was then making on this market. Under this scheme a rebate of 5s. per ton was allowed on plates and sections, and 7s. 6d. on joists, on the consumers undertaking to use nothing but British steel; this has since been increased to 10s. per ton on plates and sections and 12s. 6d. per ton on joists.

During 1929 the British Steelwork Association was formed "to promote and develop the production and use of constructional steel and steelwork, etc.": this Association is composed of the important firms engaged in the manufacture of structural steel or in structural engineering. In furtherance of its objects the Association, jointly with the Department of Scientific and Industrial Research, is contributing to a fund for a general investigation into the problems bearing on the use of steel in structures. The British Steelwork Association will seek primarily to develop the use of steel in the home market. Another association—the British Steel Export Association—has been formed to develop the export market, and in the first instance is centralising the selling of plates, sections, joists, etc.

The industry is also making great efforts to reduce costs of production by technical improvements and fuel economy. A Fuel Economy Committee was set up by the National Federation of Iron and Steel Manufacturers in 1923, and has been so successful that there was no difficulty in obtaining substantial financial support from the "Department of Scientific and Industrial Research" for an Iron and Steel Industrial Research Council, with much wider aims than the original Committee. The work of the new Council will cover investigations into production problems connected with blast-furnace and steel-furnace practice, rolling mills, and other problems. It is not proposed to undertake researches of a "fundamental" nature such as are at present being pursued by the National Research Laboratories, the Universities, etc.

It will thus be seen that iron and steel makers are doing their utmost under most difficult circumstances to restore prosperity to their industry which is so vital to the welfare of the nation.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for February, report that production of pig-iron and steel was maintained at a fairly high level in February, the rate of production in both cases having been slightly higher than in January. The output of pig-iron amounted to 597,000 tons in February, compared with 650,000 in January (giving a daily rate of 21,300 tons compared with 20,970 in January), while steel output amounted to 776,400 tons compared with 771,100 in January, the increase being largely due to the fact that holidays were being taken in Scotland at the beginning of the year. The increase in the number of furnaces from 159 to 162 was due to five furnaces, having been damped down, resuming operations during the month, while two other furnaces ceased operations during the month.

The Board of Trade's price index number for iron and steel in February was 114.7 (1913=100) compared with 115.2 in January. The index number for "all commodities" in February was 127.8 compared with 131.0 in January.

Returns received from 136 firms employing 87,009 workpeople in February show a decrease of 177 compared with January and an increase of 696 compared with February, 1929. According to returns from 138 firms employing 115,147 workpeople the average weekly earnings per head in January amounted to £3 0s. 10d., compared with £2 18s. 5d. in December and £3 2s. 3d. in November.

Random Shots.

The passing of the Engineers' Club has been a matter of but small satisfaction to the dwindling band who remained faithful to the last. The club seems to have had all the usual elements of success, including a really first-rate situation in the heart of the West End, and it recently enjoyed all the advantages of free publicity over its fires. Yet its career has long been a chequered one, and although few will regret it for sentimental reasons, its demise is something of a reflection upon a profession that claims, not without foundation, to know how to manage things. One may, perhaps, be permitted the reflection, by way of epitaph, that had the Engineers' Club contained a few more engineers and been rather more of a club its fortunes might have been different. Certainly the traditional "clubman" of fiction would have found the situation just a trifle noisy, although extremely convenient, especially for the study of silk stockings in the passive and the active. . . . Quite a considerable group of members represented foundry interests (not in silk stockings; what an idea!), and the club was a very useful rendezvous, both for Londoners and for visitors. (I hear, incidentally, that a number of these are joining the Hambone Club.)

* * *

I believe that London has recently been—and may still be, for all I know or care—the scene of an Ideal Home Exhibition, and the fact has given me an idea. No, I am not suggesting that you should visit Olympia forthwith; there is a time and a place for everything, and the time and the place in a man's life for the Ideal Home Exhibition is when his best girl begins to pester him about house agents or his wife decides to install a green marble bathroom. The name, you see, is misleading; you would only be disappointed if you went hoping for instruction in the art of letting the wife have the last word, or the craft of putting the baby to sleep in two minutes and a-half. No; this is my idea, and for what it is worth I here present it free, gratis and for nothing to the organisers of the next foundry exhibition. Why not emulate the Ideal Home Exhibition and have an Ideal Foundries Section? It could include a modernist foundry (probably of German design, and decorated in black and silver with nickel-plated fittings); a foundry equipped with genuine antiques (preferably nineteenth-century English); a Robot foundry, complete with automatic loud-speaking foreman (records available in English, American, French, German and Hindustani); and, of course, a foundry built to the prize-winning design in an Ideal Foundries competition (organised by The Foundry Trade Journal and probably won by a first-year apprentice moulder). Let me add that I believe the Ideal Houses are *not* commonly shown in occupation. . . . !

* * *

I was reminded the other day of the old, old rule that a preposition is a bad word to end a sentence with. Here is the new gem, the effort of a small girl: "Why did you bring that book for me to be read to out of from for?"

* * *

But the prize goes to the high potentate in Palestine, who was about to entertain the British Commander-in-Chief (have I got his title right?). He initiated a careful inquiry with the object of ascertaining the English national drink, for he took pride in doing the correct thing at his banquets. As a result the distinguished guest was welcomed by a brimming tumbler of Eno's Fruit Salts!

Marksman.

Steel Castings.*

By T. M. Service.

Experience has demonstrated, as a result of many years usage, that steel has many desirable properties, and that within certain limits it has fulfilled successfully the duties which it has been called upon to undertake. Within recent years engineers have demanded more uniform properties, particularly in material subjected to high temperature or high pressure, or both combined.

Fig. 1.

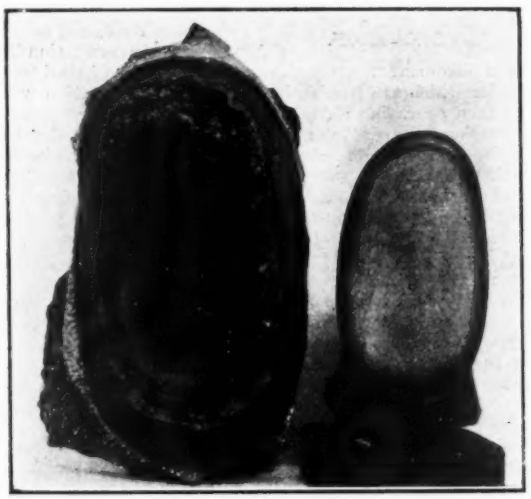


Fig. 2.

As a consequence of these demands steelmakers and metallurgists have been compelled to investigate, as fully as possible, with the equipment at their command, all forms of steel ingots and castings.

In 1924 the Iron and Steel Institute formed a committee to investigate steel ingots, and the record of these investigations up to date are to be found in the Iron and Steel Institute Journals: 1926, Vol. 113; 1928, Vol. 117; and 1929, Vol. 119. These papers and the bibliographies which accompany them give a very complete *résumé* of the subject. The results shown by these investigations demonstrate that steel is not a homogeneous material. Several of the elements or compounds of which it is composed segregate; in addition, there is distributed through this mass in greater or less quantity and sometimes segregated non-metallic compounds, produced partly by the reactions in the melting furnace and partly by erosion of the brickwork during the casting operation.

Briefly summarised, steel, when cooling from the fluid to the solid cold condition, shows the following phenomena: (1) It evolves gas; (2) it contracts in volume; (3) it contracts superficially; and (4) several of its constituents segregate. With those four prime factors the steel founder has to deal, and it is necessary that the knowledge of the time of origin and extent of their action should be given him in order to help him to successfully produce sound castings.

The evidence of the four factors mentioned are seen in castings by the following defects:—(1) Blowholes due to gas being trapped during solidification of the metal; (2) piping, due to insufficient or badly designed feeding heads; (3) (*a*) hot tears, due to obstruction in contraction during the passage through the high temperature range, (*b*) tension cracks, produced by stress induced by non-uniform cooling, and (4) the effects of segregation which are often accompanied by slight internal tears, and are usually found in castings where considerable metal has been removed during the machining operation. There are other defects which occur in castings, such as patches of sand or other refractory material washed from the mould during casting and trapped in the solidifying material, etc., but with these it is not proposed to deal.

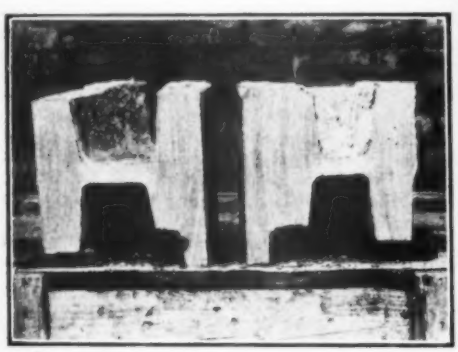


Fig. 3.

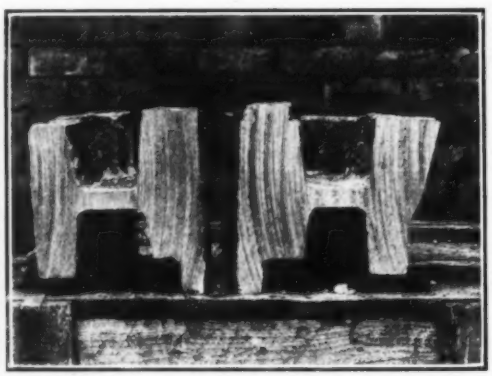


Fig. 4.

The quality and temperature of the steel have an important influence on minimising the effects of the four prime factors mentioned, and it is with these it is proposed to deal.

As personal experience in castings has been principally with the use of acid open hearth material, the author proposes to confine his remarks to this quality of material. It is known to many steelmakers who have to cast steel into iron or steel moulds, that some qualities of steel which make satisfactory plates, forgings, etc., are often unsuitable for making steel castings of thin or moderately thin sections. The same point arises when casting into composition moulds; some qualities of steel produce sound castings, others have numerous blowholes.

It is customary in many cases to add a percentage of aluminium to the steel, and this reduces the tendency to the formation of blowholes, but, in some cases, does not altogether prevent their formation. The formation of these blowholes must be due to an evolution of gas, and the question arises, can steel be produced which, when cast into composition moulds, has this tendency to gas evolution reduced to a minumum. Experience has demonstrated that this point is controllable.

If, when a charge of steel is worked and before any deoxidising elements are added, a steel sample covered with slag is drawn, different types are obtained, but only two of these will be described:—(1) The steel is solid and the upper surface, *i.e.*, the surface below the molten slag, has a rough pitted surface; (1*a*) the slag is glassy, and the gases which escape from the cooling steel are trapped on the inside surface of the slag; (2) the steel is solid and surface clean and free from blowholes, but has what is called surface-tension lines on the surface, and (2*a*) the slag is glassy, and no gas bubbles appear in the slag. Fig. 1 shows steel and slag sample 1 and 1*a*, and Fig. 2 shows steel and slag sample 2 and 2*a*. Steel of Types 1 and 1*a* is suitable for boiler plates, etc., but 2 and 2*a* is the type most suitable for castings, and certainly is the type which gives castings free from blowholes.

It is well to emphasise the point that the steel samples are drawn before any deoxidisers are added. The question can rightly be raised, why do the final additions of ferro-manganese and ferro-silicon, which leave in the finished product anything above 0.6 per cent. of manganese and over 0.30 per cent. of silicon, do not have the same effect. The reason has not been sufficiently proved, but the following assumption is put forward, viz., steel of quality 2*a* has been reduced so that it contains a minimum amount of oxides, equilibrium exists between bath and

* A Paper read before the Scottish Section of the Institute of British Foundrymen, Mr. H. Winterton presiding.

slag covering and for the particular temperature ruling at the time, the steel contains a minimum amount of gas. On solidification a large percentage of the gas remains in solution. Steel of this type usually contains 0.08 to 0.12 per cent. silicon and manganese before deoxidisers are added.

Fig. 3 shows two castings made of steel of quality No. 2. It was cast into a composition mould, which was taken directly from the drying oven, and consequently hot, and filled immediately. As seen, the steel is solid and free from blowholes, but a trace of contraction cavity is shown. Fig. 4 is the same steel cast into a similar mould, but in this case the mould, after drying, was allowed to attain atmospheric temperature, and lay in the shop one week before casting. This casting also is sound and free from blowholes.

The steel from which the castings shown in Figs. 3 and 4 were made had all the deoxidisers added in the furnace. No aluminium was added. The composition of the steel was as follows:—C, 0.46; Mn, 0.67; Si, 0.394; S, 0.053, and P, 0.042 per cent.

Fig. 5.

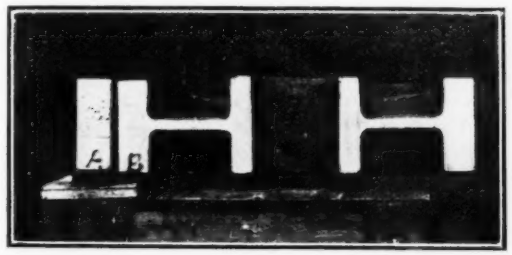


Fig. 6.

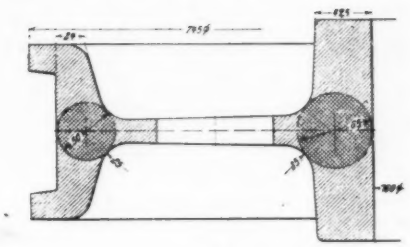


Fig. 8.

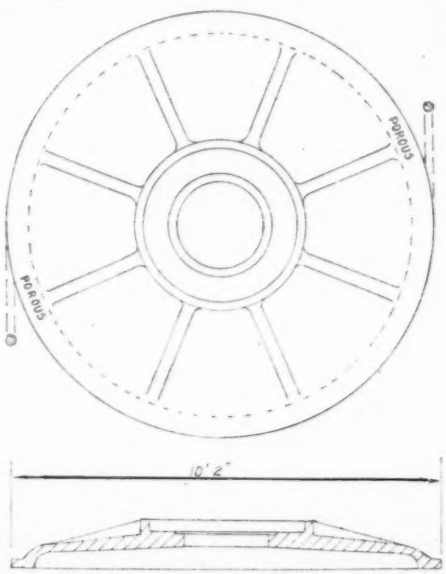


Fig. 7A.

Blowholes found in castings may be of three types:—(*a*) Completely dispersed through the mass; these occur in thin and moderately thin sections. Their origin is primarily due to steel which is in a highly oxidised condition, and in which steel a reaction is proceeding during the time of casting.

That reactions do take place in steel for some time after deoxidisers have been added was investigated some years ago, with the following result:—

Steel of Type No. 1.

	SiO_2.	FeO.	MnO.	CaO.
1st mould ..	46.00	12.29	28.43	0.50
4th ,, ..	50.16	8.83	30.55	0.44

Steel of Type No. 2.

	SiO_2.	FeO.	MnO.	CaO.
1st mould ..	46.44	6.62	35.05	0.44
4th ,, ..	47.04	6.43	34.37	0.40

Fig. 5 illustrates a bar in which numerous blowholes are present. Examination of those holes shows that the surface is smooth and completely free from oxidation. It is worthy of note that often in castings which have heavy and thin sections it is only in the thin sections that the blowholes are present; in the heavy sections, where the metal remains fluid for some time, no blowholes are present, apparently due to the fact that the gases have time to rise to the surface and escape. The section shown is a test bar cast on the side of a thick section. The thick section was machined and bored, and no blowholes were detected.

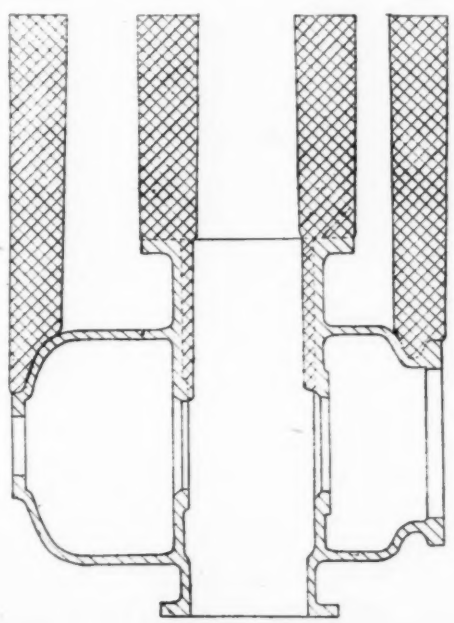


Fig. 9.

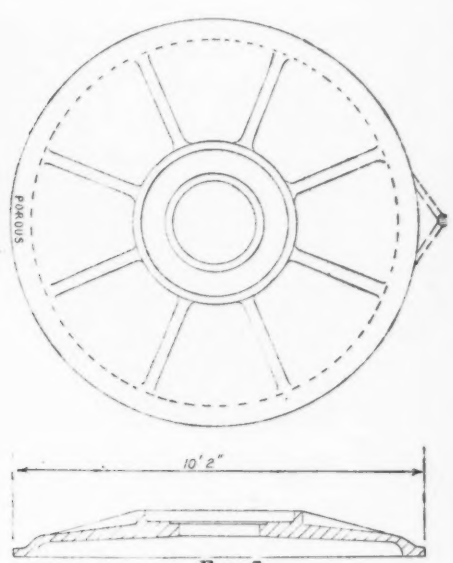


Fig. 7.

(*b*) Blowholes occurring below the skin surface and extending from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. deep, the remaining section of metal being solid and free from such defects. This type usually occurs in metal cast at a low temperature, and which is sluggish during teeming. Castings of large surface area are particularly prone to this type of defect.

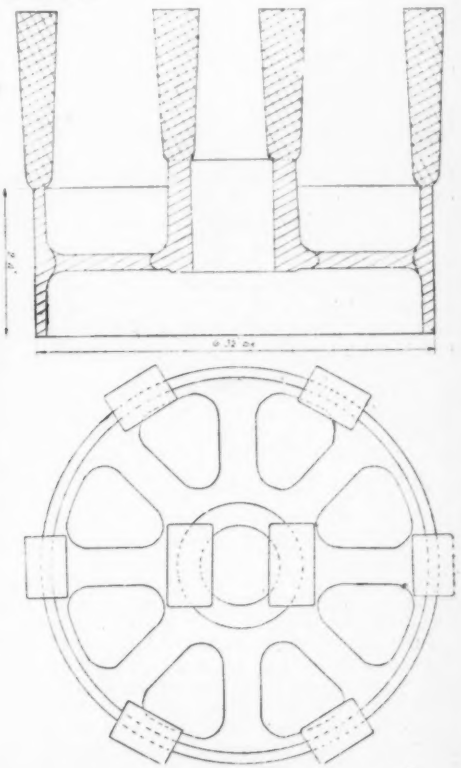


Fig. 10.

Fig. 6 shows a casting which has this type of defect, the blowholes being underneath the skin, but the remainder of the metal being solid.

D

"A" is the skin surface, and was cut at right angles to surface "B." Blowholes of this type are usually local. An attempt was made to locate these defects in relation to the runners, and the following shows their approximate position. Fig. 7 shows a large casting—10 ft. 2 in. dia. In the case shown, two single runners were fed from one feeder, and the position of blowholes in relation to runner was approximately opposite. Fig. 7A shows the same casting, but fed from two runners at 180 deg. from each other, and each runner fed separately. As seen, the area containing blowholes in this instance is immediately behind the runners. The origin of this type of defect appears to be associated with temperature of steel and speed of flooding the surface area. Sluggish metal or slow teeming, whereby the metal flowing over this comparatively cold surface so that when it attains the limit of the distance it has to travel, may have become pasty and a slight surface oxidation has taken place. After an interval of time this spot has several inches of fluid metal, but the oxide first formed appears to react with the silicon and manganese in the steel with the evolution of gas which becomes trapped. This type of defect is frequently seen at the bottom end of ingots over 7 ft. dia. cast in cast-iron moulds using a very small nozzle, say 1½ in. to 1¼ in., which contains a very slow covering of the cast-iron bottom.

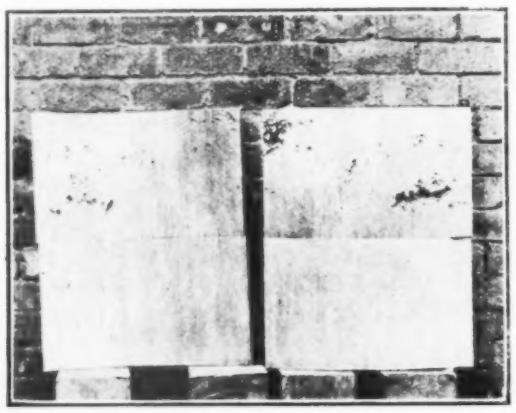


Fig. 10A.

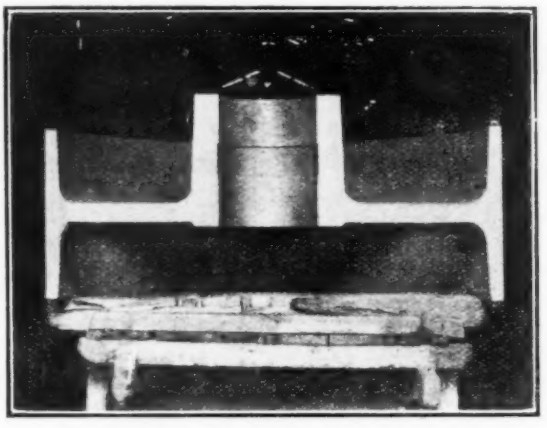


Fig. 11A.

Volume Contraction.

All foundrymen know that steel contracts in volume when cooling from the fluid to the solid condition. A cubic foot of solid steel weighs approximately 490 lbs., which gives a density 7.85. The recent determinations of the density of steel at a temperature of 1,480 to 1,500 deg. C. are given as approximately 7.0, so that 1 cub. ft. of fluid steel will weigh approximately 437 lbs., that is, in order to obtain 1 cub. ft. of solid steel 1.12 cub. ft. of fluid steel is required, equal to about 12 per cent. Every steel founder knows that castings cannot be made with a loss of only 12 per cent., the loss due to excess metal required for heads varying between 30 to 40 per cent. The work of the steel founder is made difficult by the fact that many designers fail to take into account the particular phenomenon just mentioned, viz., volume contraction.

In a paper by Heuvers, which appeared in "Stahl und Eisen," on August 29, 1929, the following example, Fig. 8, is taken. It represents a section of a crane wheel. The circles at the junction of boss and rim show the areas, which are respectively 65 mm. dia. = 3,318 sq. mm., and 50.0 mm. dia. = 1,963.5 sq. mm., and the corresponding sections at rim are 47.5 and 24 mm. If the wheel is cast as designed, the last portion to solidify will be the centre of the 65 mm. and 50 mm. sections. It is known that by thickening up the inside of the flange and boss one can successfully feed those heavy sections, but the removal of the excess metal is costly.

Fig. 9 shows a section of an Admiralty valve; as seen, the valve seat has a greater section of metal than the walls of the valve through which this section has to be fed; here again the valve wall has to be thickened up in order to feed satisfactorily the seat. The excess metal necessary to feed the valve seat had to be machined off.

Fig. 10 shows a spider on which six heads have been cast, the area of the junction of head and wall being the thickness of the finished wall of the casting. Fig. 10A shows that at the junction of arms and wall a contraction cavity has formed.

Fig. 11 shows the same spider with only four heads, but in this case the metal is thickened up and carried down below the junction of arms and wall. In this particular case, on the inside, owing to the heavy accumulation of metal, eight tears ¼ in. deep appeared; those hot tears were made visible when a ¼ in. deep machining cut was taken on the inside. The trouble in this case was overcome by dividing the metal used for feeding head between outside and inside of casting, that is, where originally the outside had a thickness of metal 1½ in., in addition to wall thickness it had ¾ in. outside and ¾ in. inside. This casting was sound and free from piping. As seen, this extra metal increases costs considerably, as the excess metal in each case has to be removed by machining.

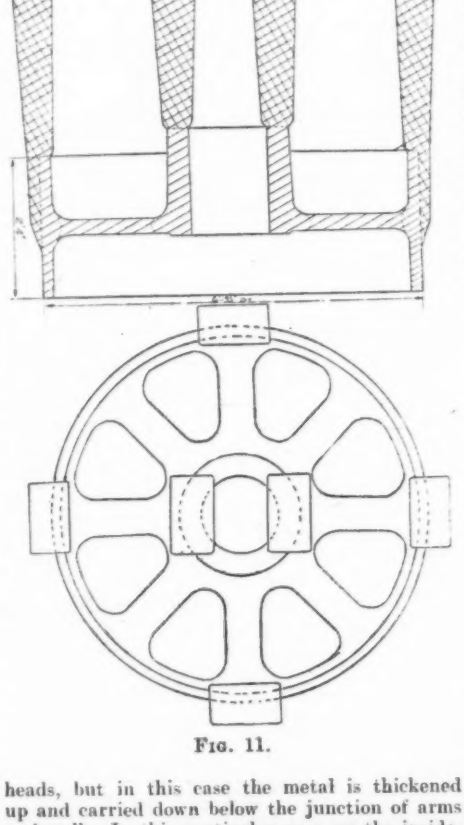


Fig. 11.

(To be continued.)

Formation of Graphite.

Influence of Phosphorus.

Considerable difference of opinion has been expressed concerning the influence of phosphorus on the precipitation of graphite in cast iron, and it has been generally accepted that this element aided the formation of graphite. Careful observations by von Keil and Mitsch led to detailed study and an explanation which is based on the constitution diagram (Fig. 1) of the Fe-C-P system.

An increase in carbon content above the eutectic composition in iron-carbon alloys is accompanied by a decrease in the tendency to precipitate graphite. In the ternary system, it is evident that the iron-carbon eutectic, represented by CE becomes lower in carbon as the phosphorus content increases. Thus a hypo-eutectic iron may easily become hypereutectic when its phosphorus content is sufficiently high. This, as is the case with pure hypereutectic iron-carbon alloys, would stabilise the graphite.

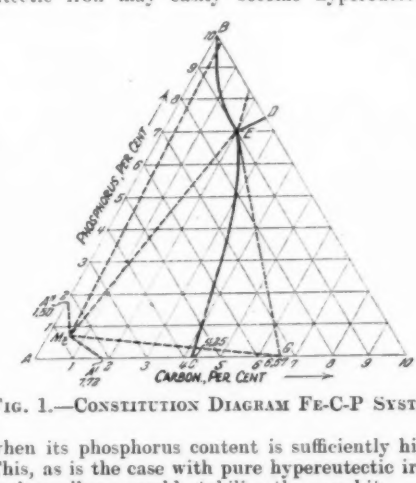


Fig. 1.—Constitution Diagram Fe-C-P System.

A number of charges having different silicon contents and cooled at different rates indicated that earlier observations believed to be due to phosphorus, that is, the ready separation of graphite, is really due to the presence of silicon and to slow cooling.—"*Stahl und Eisen.*"

Some Technical Aspects of the Electric Steel Foundry.*

By D. K. Barclay.

There are many forms of electric furnace, differing in design, it is true, but all employing the heating effect of electric current producing an arc between electrodes, or from the resistance of the molten metal to a heavy current passing through it. The furnace with which the author is most familiar is a 7-ton Heroult type worked with a basic hearth. It has a charging door on each side and a teeming spout in front. It is designed with a circular bath over which are arranged in triangular form three graphite electrodes of 18 in. in dia. It is operated by 3-phase, 40-cycle current, with two tappings, one 85, the other 95 volts; under these conditions the current per phase rises to 6,000 amps.

The current is taken from a high-tension circuit of 11,000 volts, 3-phase, and stepped down by means of three 500-kw. transformers. The current is carried from the transformers by low-pressure leads to copper bus-bars, leading to the electrode-holders. The leads of the different phases are symmetrically placed with reference to the transformers, and are of sufficient length to allow for the furnace being tilted for slagging and teeming purposes.

The bus-bars leading to the electrodes are of copper and extend at right angles from the vertical framework to the shell of the furnace. The connection between bus-bar and electrode is made by an inner copper lining on the steel electrode-holder, suitable mica insulation being employed.

The raising and lowering of electrodes when the furnace is in operation may be made by hand or by automatic.

At the completion of a melt the furnace is tilted on rockers by a 12-h.p. motor, placed underneath the rear of the furnace and geared to a screwed rod, which lifts the furnace bodily.

Building the Furnace.

The furnace itself is built in hexagonal shape of ½-in. steel plate riveted together and securely fastened to two steel rockers. To line the furnace the entire bottom is bricked with fireclay bricks, on edge, and bedded on to the shell in ganister. The side walls are built with a double thickness of magnesite bricks to about 9 in. above the sill of the side doors; above that the lining is continued with silica brick to about 6 in. above the top of the furnace shell.

The material for the bottom is made up by mixing burnt dolomite of about walnut size, which has been previously heated to about 100 deg. C., with hot dehydrated tar. This mixture of tar and dolomite is spread on the bottom in layers of about 3 in. thick, and each layer well rammed with hot rammers. Too much care cannot be taken in ramming the bottom. On completion of bottoming, a thick layer of ganister is spread all round the top of the brick walls, and the roof, which has been previously built into a steel rim on a template, is placed in position and clamped to the furnace shell. When properly built, the lining of a furnace such as described should last about two months. With care during melting and attention to repairs on completion of a melt, a bottom should be capable of melting about 3,000 tons of steel.

The electrodes are placed in position and the furnace charged with foundry coke; the current is switched on, and the process of sintering in the bottom begun. The tar is burnt out and the bottom brought to condition by easy stages of alternate heating and soaking periods, until a temperature of about 1,600 deg. C. is reached.

* A Paper read before the Middlesbrough Section of the Institute of British Foundrymen, Mr. Ridsdale presiding.

Steel Making Process.

The furnace is raked clear of coke and charged with steel scrap, which may consist of crop ends, plate scrap, punchings, turnings and the usual foundry scrap from the dressing shop. The assertion that in such a furnace good steel can be produced economically by charging up any old scrap is not quite according to facts; it is imperative that as much consideration be given to scrap for this type of furnace as for any other.

The usual procedure is to charge 20 or 30 lbs. lime on the bottom of the furnace, the amount depending on the quality of the scrap, following with the heavy scrap first, lighter scrap next, and on top a liberal amount of turnings. When charging is completed, the position of electrodes is noted, and if sufficient clearance is apparent, the power is switched on and melting commenced by lowering the electrodes until an arc is formed between the points of the electrodes and the scrap. At first, local melting takes place around the electrodes. As the electrodes melt or bore their way through the scrap a pool of molten metal collects on the hearth. Having now obtained a bath the dephosphorising slag is added, in the form of lime. The omission to mention iron ore or mill scale is intentional, the reason for so doing will be apparent later in the Paper. The input of power is kept as high as consistent with safety until the entire charge is molten and the bath attains a large measure of superheat. Too much stress cannot be laid on the importance of superheating the bath previous to refining, as it is essential if good steel, free from inclusions, is the object in view.

The reactions which take place during the oxidising period are as follow:—The carbon present in the bath combines with iron oxide to form carbon monoxide and iron; the manganese and silicon are oxidised to manganous oxide and silica—either separately or as a silicate of manganese. The carbon, silicon and manganese having now been removed from the bath the elimination of phosphorous proceeds, in combination with iron oxide the pentoxide is formed, which in turn combines with the lime to form calcium phosphate. Providing the required degree of superheat has been attained, the power is switched off, the furnace slightly tilted, and as much of the slag as possible allowed to run off, any slag remaining is raked off with rabbles.

A typical dephosphorising slag from a melt by the partial oxidisation method is as follows:—SiO_2, 16.26; FeO, 8.41; Al_2O_3, 2.84; MnO, 4.37; CaO, 53.23; MgO, 13.78; and P_2O_5, 0.82 per cent.

When making steel for castings, it is rarely necessary to carburise the bath after the removal of the oxidising slag, sufficient residual carbon having been left in the bath—the deoxidising and desulphurising slag may now be thrown on.

There are two types of electric-furnace slags in use. One, usually called the white slag, composed of lime, anthracite and fluorspar, but deficient in anthracite to such an extent that there is little chance of obtaining the necessary volume of calcium carbide. The other—the carbide slag—is the most efficient medium for the dual purpose of deoxidising and desulphurising. It is composed of approximately 6 parts of lime, 2 parts powdered anthracite and 1 part fluorspar, the whole having been thoroughly mixed on the stage before being thrown on.

On this slag showing signs of fusion, it is fed periodically with small quantities of powdered anthracite until the proper atmosphere has been obtained, that is, one reducing in character, and associated with a highly basic slag.

The purpose of this slag is to desulphurise and deoxidise, and functions as follows: Through the agency of carbon or calcium carbide any reducible iron or manganese oxides are reduced to their respective metals and returned to the bath; on the slag becoming free of metallic oxides the deoxidation of the bath commences, and as new metal surfaces present themselves to the action of the slag the iron and manganese oxides are reduced, the sulphur is eliminated and retained permanently in the slag as calcium sulphide. Whilst deoxidation and desulphurisation proceeds, degasification can be commenced by periodical additions of powdered ferro-silicon in small lots of a few lbs. at a time.

At this stage samples are taken from the bath and run into a small mould on the stage; immediately on obtaining a sample which lies quietly in the mould it is sent to the laboratory for the estimation of carbon and manganese. On receipt of the figures the amount of finishing alloys, in the form of ferro-silicon, ferro-manganese and hematite, are calculated, necessary to bring the bath to the specification desired.

Time is allowed for the alloys to melt, and then the bath is thoroughly rabbled, the current switched off, and advantage taken of the superheat imparted in the oxidising period by allowing the bath of steel a few minutes' rest before teeming. This resting period ensures the completion of the reactions arising from the addition of the final deoxidisers, inclusions which at a lower temperature would be entrapped are free, and fluidity is increased. Final samples are taken from the bath, and if satisfactory from solidity and temperature points of view, the steel is run into the ladle.

Adverting to the selection of scrap for the electric-furnace process, it can be stated that whilst it is much easier to melt inferior scrap with complete oxidation, it is not conducive to the production of the best steel. Obviously, if one overloads the bath with oxides in the form of ore or scale at the commencement of the melt, difficulty arises in getting rid of the dissolved oxides later. The writer believes that the best and most economical method of producing electric steel for castings is to use scrap with a minimum sulphur and phosphorus content of 0.065 per cent. Restrict the addition of oxygen to the rust and scale adhering to the scrap, and it will be found that sufficient oxides have been added to reduce the phosphorus to within practically every steel-casting specification.

Having restricted the oxides, it follows that deoxidation under the carbide slag takes less time, nothing is sacrificed in quality, but the saving in time, deoxidising alloys and electricity more than compensates for the difference between the price of good scrap and bad scrap. A typical furnace charge sheet reads as follows:—

Weight of charge, 7 tons.
Total time of melt, 5 hrs.
Melting loss, 8 per cent.
Units per ton, 800.
Electrodes, lbs. per ton, 15.

Ladles are of the bottom pouring type, lined with firebrick and having a protective inner coating of ganister. Stopper ends, sleeves and nozzle pots are renewed for each heat. When dealing with liquid steel in the foundry the importance of pouring rate and pouring temperatures are often overlooked. To secure good results, the flow of metal from the ladle to the mould should be under control. Pouring should be commenced at as fast a rate as is possible without injuring the mould, and input of metal eased off as the mould fills. This method allows the solidifying bottom part of the casting to benefit from the metal running in, and leaves less work for the feeding head.

Influence of Pouring Temperature.

Hot pouring and cold pouring each have advantages and disadvantages. Hot pouring allows solid non-metallic inclusions and gases to rise to the top, but it favours segregation, cracking, excessive shrinkage, burning-on and very often is responsible for the large crystallisation known as ingotism. Hot pouring may be advantageous in foundries where the Siemens open-hearth and converter processes are in use, as a means of getting rid of inclusions, but in the electric process cleansing can be done in the furnace. Cold pouring means quick solidification with less risk of cracking, but does not always give sharp impressions of the mould, with the added danger of short runs and overlap. Generally speaking, steel should be poured at as low a temperature as is consistent with fluidity, any excess is not of definite value.

Electric steel having survived much prejudice is now recognised as being a very suitable steel for the production of steel castings, because of its freedom from sulphur and phosphorus, non-metallic impurities, and gas, also the high temperature attainable in the furnace, which makes it possible to pour successfully castings of thin and intricate design.

Earlier in the Paper it was shown that it is practically free from reaction products in the form of iron and manganese oxides. Also with well-deoxidised steel non-metallic inclusions as represented by silicate reaction products are absent. The only product of reaction which may be present is manganese sulphide, but, taking into consideration the fact that in most electric steels the maximum sulphur content is 0.030 per cent., the resultant manganese sulphide possibly present is negligible. Admitted that with complete oxidation the amount of dissolved ferrous oxide present may be injurious, but with the partial oxidation process as outlined ferrous oxide should be absent, or at least confined to a little which may be held by mass action.

Comparing electric with open-hearth steel it is found that the possibility of gas inclusions are less in the former. In open-hearth there is an oxidising atmosphere in the furnace, due to the heating agent-producer gas; there is always the possibility of contamination of the steel by nitrogen, and possibly small quantities of hydrogen from dissociation of vapour and from the oxidation of carbon to carbon monoxide. In the electric there is little or no introduction of atmospheric oxygen, with no possible risk of contamination by *nitrogen or hydrogen. As carbon monoxide is the only gas that can be present in electric steel, it is at once apparent that in so far as occluded gases are concerned, it is superior to open-hearth from a steel castings point of view.

Of late years much discussion has taken place with regard to the relative fluidity of electric and converter steel, much to the detriment of the former. Suggestions have been advanced with a view to explaining the assumed better fluidity of converter steel as follows:—By the presence of dissolved oxides, or by incomplete reactions between finishing alloys in the ladle, or through high temperature conditions. The writer accepted the assertion that converter steel was superior to electric steel from a pouring point of view, but during the past two years, having had the opportunity of studying the characteristics of converter steel made by the Tropenas process, he is not prepared to admit that any marked difference exists in that respect. While making no definite statement, he inclines to the view that reactions between dissolved oxides and finishing alloys in the ladle are responsible for the assumed superior fluidity.

In support of that contention it can be postulated that some time ago, in an effort to correct a certain defect in converter steel, the steel was allowed to stand for a few minutes in the furnace after the addition of finishing alloys, thus giving the alloys time to complete their work. It is surely more than a coincidence that since commencing that practice the steel does not hold up as long, and that a superior steel is obtained from an inclusions point of view.

With regard to the high-temperature conditions, experience shows that, no matter how hot either converter steel and electric steel may be originally, if full of oxides they will chill rapidly on pouring. On the other hand, if action is taken to rid either steel of oxides they will run when surprisingly cold.

If by any chance the impression has been conveyed that makers have been free from trouble and worry in the electric melting of steel for castings, it should be dissipated. Steel has been encountered which refused to be "killed," and eventually ended in the pit; another type of steel, after much expenditure in ferro-silicon, gives the impression that it will teem quietly, yet subsequently leaves the moulds by way of the risers. Happily the visits are of very rare occurrence now, a state of affairs attributable to the partial oxidation method and rigid technical control.

Before concluding this section it should be stressed that an appreciable percentage of the steel foundries' difficulties in manufacture could be avoided if a greater measure of co-operation were obtained between the designers and the manufacturers. It is realised that in the case of foundries which execute a large quantity of their work with customer's patterns, such co-operation is more difficult to secure, but it should not be impossible.

Moulding Sands.

Steel foundry practice includes two methods of moulding green-sand and dry-sand. As the name implies, green-sand moulds are made from sand in its green state, any moisture in the sand is retained up to the time of casting. This method is largely confined to small work, and castings on which little or no machining has to be done. In dry-sand moulding the same procedure is followed as with green-sand, excepting that the moulds are dried after making in stoves at a temperature of approximately 300 deg. C.

For steel moulding purposes the moulder has the choice of two different types of sand, naturally bonded sands, carrying their own bond and having sufficient cohesiveness to be used without the addition of artificial binders. Then there are the synthetic sands made by mixing a pure silica sand with a refractory fireclay.

In selecting a sand for the steel foundry there are several essentials which must be kept in view, namely, refractoriness, cohesion, porosity and permeability.

Obviously in sands which have to withstand temperatures up to 1,650 deg. C., refractoriness is of the greatest importance. This property is dependent on the amount of silica and alumina present, and, of course, alkalies in the form of sodium and potash should be a minimum quantity.

Alkalies and alkaline earths combine with silica to form silicates, thereby causing fluxing at high temperatures, with subsequent "burning on" of sand from the face of the mould. It is desirable that the sand will be chemically stable at high temperatures, without altering its shape during pouring, and be able to withstand the flow and pressure of molten metal. A sand with as coarse crystals as circumstances permit and containing as little silt as possible, is recommended. Silt lowers the refractoriness as well as impeding permeability.

The next consideration is cohesion, or bond, a property which in natural sands is governed by the amount of iron oxide and clay present in the sand. The colloidal clay cements the sand grains at their points of contact. All natural sands do not contain the requisite proportion of natural bond, so that the moulder has to resort to artificial bonds in the form of dextrine, molasses, linseed oil and other vegetable oils. Present-day practice seems to favour the selection of very refractory sand, with the deficiency in bond made up artificially.

According to Boswell all successful bonds, whether natural or artificial, belong to that class of bodies known as colloids. The essential point about colloids and one bearing on their presence in moulding sands is their exhibition of surface phenomena. In other words, their special properties are to be ascribed to surface energy.

The life of sands is very much affected by the nature and extent of colloidal constituents present, the properties of which are modified by heat above a certain temperature. Sands with a clay bond will withstand a fairly high temperature, and providing they are not subjected to sintering will again hydrate and can be used for further work. If they are subjected to sintering, they lose the colloidal property of again taking up water, and consequently will not again take up bond.

A maximum specification for the main constituents, apart from silica, is as follows:—

	CaO or $CaCO_3$.	FeO.	Alkalies.	Al_2O_3.
	Per cent.	Per cent.	Per cent.	Per cent.
Light and medium steel..	1.00	2.0	0.5	7.0
Heavy steel ..	0.5	2.1	0.5	4.0

Air present in the mould and gases generated during pouring must have free egress from the mould. Porosity is governed by the size and shape of the sand grains, the amount and character of the bond, as well as the density of the sand when rammed. Pore space should be evenly distributed—assistance in that respect may be had by avoiding sands with much variation in size of grain. Permeability and porosity must not be taken to mean one and the same thing; all sands when rammed are porous, or at least have porous places and yet they might not be permeable. Permeability is important in that it provides a way of escape for gases generated during pouring, it is also a means of getting rid of the air permeating the sand walls of the mould, which expands from the heat of the molten steel filling the mould. Sands which are badly graded and sands containing too much silt, natural bond and moisture retard permeability, and are a fruitful source of scabbing.

In heavy work hard ramming is essential to prevent swelling, but the use of the venting wire will provide for permeability. The sands at present being used by the author in the electric steel foundry are Yorkshire yellow and Belgian white, in the proportions shown in Table I measured by volume.

Table I.—*Mixtures and Composition of Sands for Steel Castings.*

Sand for light and medium work—

50 per cent. Yorkshire, 37 per cent. Belgian, 13 per cent. Floor sand.

Sand for heavy work—

71 per cent. Yorkshire, 29 per cent. Belgian.

Sand for Green-sand Work—

40 per cent. Yorkshire, 50 per cent. Belgian, 10 per cent. floor sand.

Analyses.

	SiO_2	FeO	Al_2O_3	CaO	MgO	K_2O+Na_2O	Loss on Ignition.
Yorkshire sand	82.30	1.51	11.53	0.84	Trace	0.42	3.40
Belgian white	96.40	0.41	1.51	0.98	0.22	0.18	0.30

Core Sands.

In the majority of steel castings there are volumes which the designer wishes left without steel. To meet this requirement, cores conforming to the desired shape and size are inserted in the mould. Cores may be made from natural bonded sands, or from highly refractory sands

* This is not quite true, because if a high voltage is used conditions are set up favourable for the fixation of atmospheric nitrogen.—Editor.

using oil as a binder, the latter being exclusively used by the author. Oil-sand cores have advantages over natural bonded sand cores in that they are hard and strong, call for less venting, and the necessity for core irons is reduced. They are much easier to remove from the castings in the dressing shop.

The selection of a suitable sand is equally as important as the selection of a suitable oil or binder. Most satisfaction is obtained from a high-silica sea-sand, or washed river-sand, possessing regularity of grain, and preferably not too fine nor yet too coarse. Besides being refractory it should contain little natural-bond and be comparatively free from lime and alkalies. The oil binder should be adaptable to both light and heavy cores.

In this connection linseed oil is of high value, not only from a drying point of view, but also from the high quality of the bond film it produces. Whatever form the bond takes, either as oil or composition of oil in the form of cream or paste, it should mix easily and uniformly with the sand, and give the maximum bonding power between the sand grains, as well as imparting sufficient strength to the mixture to allow of the cores being handled in the green state. It should permit of the cores standing for a time without absorption of moisture, and allow for rapid disintegration of the core after solidification of the casting.

The preparation of core sand mixtures requires careful attention. Experience has shown that the best results are obtained by drying the sand before mixing, as it permits of a more consistent sand mixture by controlling the proportion of added water. But, apart from expense, it is not always practicable to dry sand before use in foundries where large numbers of cores are made daily; good and consistent results are obtained if the precaution is taken to store the sand in the core shop for two or three days previous to use.

A number of mechanical appliances are advocated for incorporating the oil binder with the sand, but any apparatus is good for the purpose which does not crush the sand and ensures the thinnest possible coating of binder being spread around each sand grain.

Drying of Cores.

The drying of cores is not simply a matter of drawing off moisture, the stove must be of a type capable of supplying the hot air for the oxidation of the oil binder, and be capable of attaining and maintaining a temperature suitable for the baking of the cores to the familiar nut brown colour. Investigation has proved that to obtain a core of the desired strength with minimum gas content, it is necessary to bake at temperatures between 230 and 260 deg. C., and where linseed oil is used preferably at 250 deg. C.

Suitable cores for electric steel may be made from admixtures of Belgian white sand and Pickering loam, the percentages given being by volume in Table II.

TABLE II.—*Mixtures and Composition of Sands for Cores.*

Light and medium work—
64 per cent. Belgian, 33 per cent. pickering loam, 3 per cent. binder.

Heavy work—
16 per cent. Belgian, 81 per cent pickering loam, 3 per cent. binder.

	SiO_2	FeO	Al_2O_3	CaO	MgO	K_2O+Na_2O
Analyses strong mixture ..	90.00	1.09	6.31	0.56	Tr.	0.34
Analyses medium mixture ..	93.80	0.50	3.10	0.48	Tr.	0.12
Analyses pickering loam ..	90.40	1.47	5.50	0.48	Tr.	0.45

Heat Treatment.

In the modern steel foundry the heat-treatment of castings has become of great importance. In steels which have cooled slowly from a high temperature there are ferrite, cementite and pearlite. The proportions of these constituents vary in different steels, and are governed by the composition of the steel as a whole. The carbon is always combined with a specific amount of iron, and forms a carbide having the formula FeC_3. This carbide is made up of 6.6 per cent. iron, and is known as cementite. The balance of the iron is practically free from carbon, and is known as ferrite.

During the process of cooling this cementite will form a mechanical mixture with a definite amount of ferrite. The resultant mixture will have a carbon content of approximately 0.90 per cent. C., and consists of interstratified layers of ferrite and cementite, and is known as pearlite. Pearlite is a separate and distinct constituent of steel, having distinct grains, and comes into existence at a specific range of temperatures.

Steels containing 0.90 per cent. carbon will consist entirely of pearlite. Steels containing less than 0.90 per cent. carbon will consist of definite amounts of pearlite, with the balance made up of ferrite. A casting in the "as-cast" condition, besides being in a strained condition, is brittle and lacking in toughness.

Were the relief of strains the only consideration, heat-treatment would be a comparatively simple affair, but it is known that to get the best from steel one must break up by heating the coarse crystallisation of pearlite and ferrite and replace it by a structure in which the constituents are of the smallest grain-size obtainable. One can obtain the desired refinement of grain by heating the steel through the Ac3 point, or what is known as the upper critical range.

Structural changes take place while the steel is in the solid condition at temperatures known as the critical ranges of the steel. These changes are denoted by the letters Ac and Ar, and modified by the figures 1, 2 and 3, indicating the particular point referred to. Say, for the sake of example, a mild steel casting, with a carbon content of 0.20 per cent., is heated up and the rise in temperature recorded. On examination of the plotted curve one would find three definite interruptions, the first at 730 deg. C., known as Ac1, the second at 760 deg. C., known as Ac2, and the third at 830 deg. C., known as Ac3, or the upper critical range.

Again, on cooling, one would find three quite as definite interruptions taking place at 800 deg. C. (Ar3), 760 deg. C. (Ar2), and at 690 deg. C. (Ar1). These thermal effects do not take place at the quoted temperatures in all steels, but are governed by the chemical analyses, particularly the carbon.

The alterations in the structure of the steel passing through these points may be explained as follows:—On heating to Ac1, a change in the pearlite takes place; it reverts to the solid solution austenite. At this period only the pearlite is affected, the distribution of the constituents remaining the same, with the exception that pearlite is replaced by austenite. As the temperature advances, austenite dissolves the ferrite, and keeps on increasing with corresponding decrease in ferrite until at Ac3 we have the solid solution austenite. Having reached this point, and being satisfied that the casting is uniformly heated throughout, one must decide what manner of cooling will give the desired structure in the finished casting. If the casting is to be of very hard-wearing surface quality, and the designs allow it, one could quench in oil or water, and temper to the required extent by subsequent reheating. When the casting cools down to Ar3 (in this case 800 deg. C.) reprecipitation of ferrite from the solid solution austenite commences, continues through Ar2, until at Ar1 the austenite is reconverted to pearlite; no further change takes place. It may be more correct to say that the austenite does not directly change to pearlite, but passes first through the transition constituent, sorbite.

Were one to examine by the aid of the microscope the steel before and after annealing, one would find that the coarse crystallisation of pearlite and ferrite so apparent in the "as-cast" condition, has given place to a structure of uniformly fine crystallisation, with strong interbonding and the abolition of the long straight lines of ferrite. The following minimum and maximum limits of the upper critical range will cover the annealing of steel castings up to 0.50 per cent. carbon.

Steels up to 0.12 per cent. carbon will anneal between 885 deg. C. and 930 deg. C.; steels between 0.12 per cent. C. and 0.29 per cent. will anneal between 860 deg. C. and 900 deg. C.; and steels between 0.30 per cent. C. and 0.50 per cent. will anneal between 830 deg. C. and 860 deg. C. For normalising it is advisable to go about 20 deg. C. higher in each case.

In steel foundries making general engineering castings of assorted sizes and analyses, it is not always possible to give each casting the requisite heat-treatment temperature, but it is found that by compromising at 930 deg. C. for mixed analyses heats good results are obtainable. Successful heat-treatment demands consideration being given to rate of heating, time of soaking and rate and manner of cooling.

Charging the average steel-foundry annealing furnace is a work of art; the fact that castings are packed one on top of the other makes it a difficult matter to apply the heat in such a manner that no part of the charge is overheated. Obviously the interior of the pile will lag in temperature. The practice sometimes adopted of applying increased heat to the outside of the charge in an endeavour to force heat through to the interior is altogether bad. Far better wait the extra hour or so until the heat soaks through. Heating steel castings to a temperature much in excess of the Ac3 point tends to re-coarsen the grain; in many cases it does so to such an extent that little or no refinement of grain is discernible.

Probably the explanation of re-coarsening by overheating is as follows. The ferrite being already in solution, the increase in temperature over the critical range is unaccompanied by diffusion, consequently the crystals are enabled to arrange themselves with greater regularity, and the planes of easy cleavage are reintroduced along which the ferrite precipitates on cooling down. Castings so injured can only be rectified by reheating, preferably by the double treatment of reheating above Ac3 and cooling in air, reheating, and cooling in the furnace. When the heat has become uniform throughout the charge the soaking period is governed by the weight of the charge and the size and section of the heavier castings, and must be of sufficient length of time to ensure complete diffusion. Usually a period of from 5 to 6 hrs. will be found sufficient.

Large castings subjected to severe strains in cooling from the liquid to the solid state and, as a consequence of slow cooling, show the large crystallisation known as ingotism, require on many occasions prolonged soaking. It is peculiar that although a new structure may be brought into existence by the annealing temperature, this new structure shows a pronounced tendency in cooling to revert to the original "as cast" condition.

The cooling of a hypoeutectoid steel from above the upper critical range to below the lower critical range causes austenite or the solid solution to reject the excess ferrite to the grain boundaries. If the drop in temperature from the upper to the lower critical range during cooling in the furnace is regulated to a sufficiently slow pace, the excess ferrite will be precipitated and coalesce into definite grains. Sometimes it is inconvenient "to hang up the furnace" for a cooling such as the above, but quite near approximation of a slow cooling can be had by removing the castings from the furnace and covering with sand, ashes, or lime. Castings

(*Continued on page 276.*)

Some Recent Developments in German Foundry Practice.*

By Dr. Ing. S. G. Werner (President of the German Ironfounders' Federation).

Not many years ago, the users of cast iron were satisfied if it was soft and easily machinable. Special properties were not demanded, as cast iron was used mainly under compression load. In cases where cast iron had to withstand greater stresses the cross-sections were enlarged. If that was not enough the parts were made in cast steel. Nobody thought it to be possible to improve the quality of cast iron considerably. Therefore the engineers changed more and more over to steel castings. Even in official regulations, very often cast iron is ruled out for many parts. In the same way, cast iron lost ground where resistance to chemical action or heat was necessary. Other metals, which answered the purpose better, came into use.

Co-ordination of Interests.

About 15 years ago, there began the new development in the manufacture of cast iron, and especially did the improvement of the metallurgical methods lead to an improvement of the quality of cast iron. A few years later, in 1919, there was created in Germany a Head Committee for foundry work. On to this Committee were nominated members of the German Ironfoundries Employers' Federation, the German Foundrymen's Association, the Association of Steel Foundries and later also of the Association of Non-Ferrous Foundries. This Committee deals with all new technical problems which turn up in foundry work and transfers the necessary research work to one of the associations in order to avoid duplicated work. From time to time reports on the work of the Committee are given in public meetings.

Research in Progress.

The problems which have been dealt with in the last years were manifold; for instance, the behaviour of cast-iron and steel castings at higher temperatures, then the growth of cast iron has been a subject of researches for many years, the result being that now the steam-turbine builders are satisfied with the castings that are being delivered. Preliminary work has been started on the machinability of steel and recently also on cast iron; the properties of pig-iron of the same chemical analyses, but of different make, are studied, as are also the properties of foundry coke. Recently a special Committee has been appointed on the properties of cast iron, as the foundry owners are all convinced that the transverse test is not an absolute criterion of the properties and that also the tensile test, the deflection and the Brinell hardness do not give a complete story of the properties of cast iron.

In connection with the work of the Head Committee there has been issued the "Giesserei Handbook," now in its second edition. In this publication the foundryman finds a collection of all the data necessary for his work.

To bring all the research work that is being carried out in foundry matters to a uniform basis, the different associations have always had the closest connection with the technical colleges, and, therefore, an important influence on the technical education of foundrymen. In recent years the colleges at Aachen and Clausthal have been specially equipped for the study of the principles underlying foundry work. The different associations appointed a special committee for these colleges, and, following the advice of this committee, the foundries provide the necessary funds for research work, which cannot always be granted by the Government. In view of the very poor financial situation in Germany, it is essential that the money granted for research work must be spent efficiently and on important research only.

Properties of C.I. nearing those of Steel.

An outstanding success has been the merger of all the different interests in the improvement of the quality of cast iron. By the close co-operation of the different firms and patentees, the development of high-quality cast iron has made rapid progress. Now cast iron has won back most of the fields where steel castings had already supplanted it. In Fig. 1 is shown the

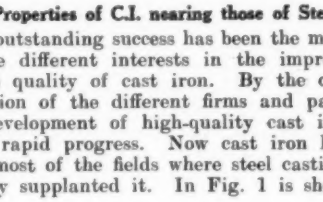


Fig. 1.—The Relative Cost of Ordinary (Gewöhntguss) and High-quality (Edelguss) Grey Iron and Steel Castings (Stahlguss), shown in relation to the Strength Properties Available.

The white columns (festigkeit) show the tensile strengths in kgs. per sq. mm., and the second columns show the cost divided into cost of liquid iron (Flussiges Material); overheads (Betriebskosten) and wages (Fertigslöhne).

relation between the maximum strength of cast iron and cast steel. The white columns show the tensile strength of the three classes of cast ferrous metals with their lower limits of 7.6, 12.7 and 22 tons per sq. in.; dotted are shown the upper limits with 11.6 and 28.5 tons per sq. in. The three columns at the right-hand side show the cost of production in three sections: the prime cost of the liquid material, the overhead charges and the salaries. This diagram shows that it is possible to produce, with comparatively little increase in cost of production, a cast iron of considerably higher tensile strength. It shows also that the costs of production for cast steel are very much higher than those of cast iron. The upper limit for high-quality cast iron differs only by about 4 kg. from the lower limit of cast steel; therefore the designer will in the future very often have to choose high-quality cast iron where heretofore he has used cast steel. To-day every good foundry is able to furnish, with the modern methods of production, castings which will answer all reasonable demands of the customer. Castings can be delivered with considerably higher tensile strength and resistance against corrosion, also special castings of very fine homogeneous structure of great density free from blowholes and cracks, even if the thicknesses in the cross-section vary greatly. It is not thought that the end of the development in the manufacture of the high-quality cast iron has been reached, but rather are founders at the beginning of great new developments. Cast iron has not only regained its place but will find new fields of application where steel and non-ferrous metals and alloys have not given satisfaction.

A New Test for C.I.

The recent development of the different melting methods are based on the composition of the raw materials, whereas in former times one relied entirely on the structure. It has been found, for instance, that pig-irons of the same analysis, but from different blast-furnaces had different properties. An extremely elaborate research work has been started to find the causes of this fact. Very probably it will be necessary to use an additional test. At the present time metallographical tests of the structure have given a first explanation; cast iron may be compared with carbon steel with embedded plates of graphite. These plates of graphite loosen the structure, varying directly with their coarseness. The best properties of cast iron are found when the structure is purely pearlitic and the embedded graphite is very finely divided up.

Perlit Iron.

Herr Diefenthäler and Herr Sipp, of the firm of Heinrich Lanz A.-G., Mannheim, have done pioneer work in this line. They were the first to aim at pearlitic structure. They selected the charges so that there was a minimum of development of graphite. This was obtained by choosing a carbon content of 3.5 per cent. or lower and a silicon content of 3.5 to 4.5 per cent. Then the cooling ratio of the castings was influenced by preheating the moulds up to certain temperatures according to the thickness of the castings. Thus they obtained castings of a structure which is mainly pearlitic. For practical purposes one has to take for heavy castings carbon plus silicon 4.6 per cent. and for light castings carbon plus silicon 3.4 per cent.

Other High-Duty Irons.

At first there were many different opinions about this invention until Prof. Maurer published the so-called diagram of cast iron. Prof. Maurer outlined in his diagram the conditions for the production of the pearlitic structure, according to the ratio of the contents of carbon and silicon. Herr Greiner and Herr Klingenstein improved the diagram by giving the ratio of the summation of the carbon and silicon to the thickness of the castings.

After the basic work of Dieffenthäler and Sipp, others have tried to produce the pearlitic structure by other methods. Prof. Wüst and Dr. Bardenheuer based their research work on the thesis that steel, with its high properties, differs from cast iron mainly by the considerable amount of graphite. They found that a carbon content from 2.2 to 3 per cent. gives the best result if the contents of manganese are about 1 per cent., and such an iron can be melted in every furnace which gives a high-melting temperature; but not so well in the cupola. This method is used practically by the so-called Sternguss of Krupp's, by Emmel-Guss, the Meehanite and the Corsalli processes. The low carbon is obtained by a large addition of steel scrap. Emmel and Corsalli have a certain way of running the furnace. Corsalli used coke which is soaked in a solution of limestone.

In malleable iron it was known that favourable distribution of graphite could improve the properties. In 1922 Dr. Schüz, at that time foundry manager with the well-known form of Meier & Weichelt, of Leipzig, produced a cast iron, with a special kind of graphite, by quick cooling-off of the iron. He called this kind of graphite "Grafiteutetikum." This eutectic appeared in common cast iron with 3.6 per cent. carbon, and in light castings, cast in sand with 3.3 per cent. Si. These castings showed remarkably good mechanical properties and a good

* A Paper read before the London Section of the Institute of British Foundrymen, Mr. J. W. Gardom presiding.

machinability at a Brinell hardness of about 150. One obtained the desired formation of graphite over the whole cross-section at a critical ratio of cooling and a certain analysis. The best formation of graphite was found with bars cast in chills. This material showed a tensile strength of over 22.8 tons per sq. in., a transverse strength of about 53.9 tons per sq. in. in bars of 0.78 in. dia. and 7.8 in. between centres. The deflection was about 0.31 in.

Whereas Schüz obtained a fine graphite by rapid cooling, Prof. Piwowarski and Prof. Hanemann obtained at about the same time, and independent of each other, fine graphite by superheating. Both worked on the same lines, but their observations and their theories differ. Prof. Piwowarski laid stress on the fact that there is a turning point at 1,500 deg. C., when the formation of carbide decreases in favour of the formation of graphite. His theory is not without opposition, but in practice it has been confirmed, that the superheating of the molten metal, especially over 1,500 deg., will always result in a finer graphite, which is favourable for all the properties of cast iron.

Herr Dechesne initiated the jarring of liquid cast iron first with the intention to obtain a decrease of the sulphur content. This desulphurising was found from the transport of liquid cast iron from the blast furnace to the mixer. It was claimed that, by the method of Dechesne, cast iron was also degasified. The results have not been such that the jarring of cast iron has been extensively applied.

As another method to obtain high-quality cast iron, recourse has been had to elements like nickel, chromium, vanadium, tungsten, molybdenum, titanium, tin, copper and aluminium, separate or in alloys from very low percentages up to 7 per cent. The experience showed that by additions of this kind, which are at the same time expensive, not very much was gained. The other methods previously mentioned showed better results. Fig. 2 is very instructive, as

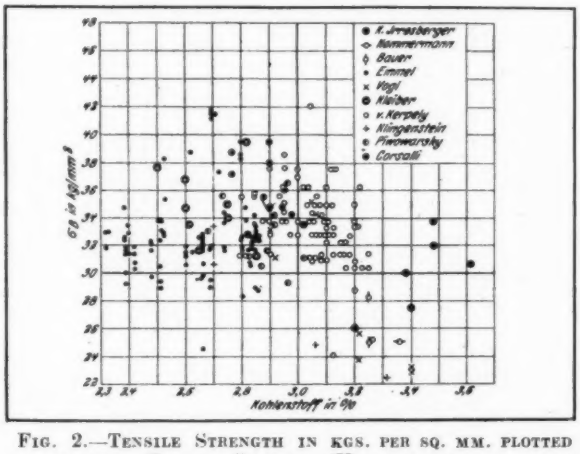


Fig. 2.—Tensile Strength in kgs. per sq. mm. plotted against Carbon Content (Kohlenstoff in per cent.) as derived by various Workers.

it shows the different results which have been given by the different methods. The points in the diagram show that it is possible to obtain a tensile strength of 19 tons per sq. in. as well with high as with low carbon content. One must, of course, bear in mind that a greater part of these results have been obtained in laboratory work or in furnaces which were very carefully operated; it is doubtful whether it is possible to obtain such results in the average foundry practice.

Furnace Requirements.

All the different processes for the production of high-quality cast iron require a higher melting temperature than was used heretofore. The question arose then to develop the furnaces for the production of higher temperatures or to find new furnaces which allow the production of higher temperatures at reasonable cost. For that purpose naturally the electric furnace may very well be used, as not only the superheating but also the analysis can be easily controlled. But the electric furnace can only be used where the price of the electric current is not too high. Of special interest were those tests which aimed at the improvement of the cupola. The first man who made a real step in advance in this direction has been Herr Schürmann. His invention goes back to the year 1912, when he took out his patent on a cupola with preheated blast. Only after the war, in 1921, the first Schürmann cupola came into operation. The results which were obtained by the Schürmann cupola were at first surprising. Fig. 3 gives an idea of the Schürmann method. For the operation of the Schürmann cupola it was necessary to have the correct amount of air at a certain pressure and a certain ratio of coke. This is, of course, also essential for every normal cupola. The foundries then started to pay more attention to the operation of the cupola, and everywhere large savings in coke were shown to be possible. Therefore one has to thank Schürmann, for it is he who has been the indirect cause of these savings. The Schürmann cupola gives, in addition to the low coke ratio, low sulphur, high temperature, and has several other advantages. Foundries which are equipped for a careful control of the operation of a cupola will find many advantages by installing a Schürmann cupola.

The further development brought to light quite a number of different cupola designs, most of which had a short life. For instance, the method of spraying water into the cupola, or the method to use an addition of coal dust, or the cupola with a number of tuyeres arranged in three screw lines on the shell of the cupola. More and more one is convinced of the fact that the normal cupola will give the desired high temperatures with low coke ratio, if the profile of the cupola and the distribution of the blast are satisfactory. The German Iron-foundry Employers' Federation has a department which is called "Giesserei-Beratungsstelle." This department takes care of the questions which are raised by the members. Several hundred visits by the engineers of the Federation to foundries have led to a new design of the cupola shaft and to the adoption of two rows of tuyeres. The tuyeres are reversible and are slanting downwards and taper towards the inside. At first the tuyeres were coupled, so that one-half of the tuyeres was always closed and in the other half open. The idea was to have the tuyeres always free from slag. However, the reversibility of the tuyeres has now been given up. The cupola which is now considered to give the best results is shown in Fig. 4. The cupola on the left shows a normal cupola, which has been rebuilt as shown at the right and at only a small cost. It is preferable to raise the height of the shaft. Then, of course, the costs are somewhat higher. Instead of one row of tuyeres there are two, of which the lower is supposed to take care of the greater part of the blast. Above the tuyeres the profile is narrower, starting a little above the melting zone until middle of the

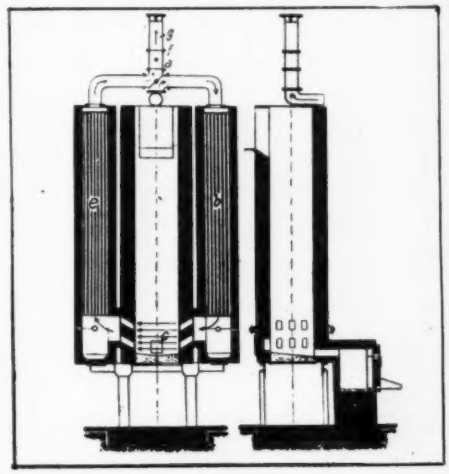


Fig. 3.—The Schürmann Cupola.

melting zone. From this point the cross-section of the shaft is cylindrical. Below the lower row of tuyeres the cross-section is enlarged to prevent the collection of the slag. By this the great advantage is gained that, at the same capacity for liquid iron, the tuyeres can be arranged near the bottom of the cupola. The liquid iron passes only through a shallow layer of coke and does not cool-off; also a saving in bed coke is obtained.

The Wüst Furnace.

To overcome the difficulties which arise when producing high temperature in cupolas, recourse has been had to the open-hearth or air

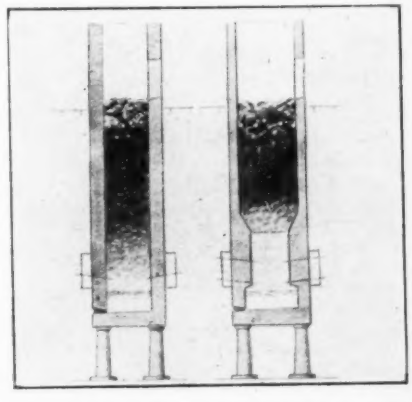


Fig. 4 shows an Ordinary Cupola and how it was Modified to Conform with that Standardised by the German Foundrymen's Associations.

In the design shown at the left it is recommended that for each sq. m. of cross-sectional area 100 cub. m. of air should be used; for the one at the right 180 cub. m. It is claimed for the design that there is no or little flame at the charging-hole, and that charges do not hang because of the dipping tuyeres; the furnaces have a 6 ton per hr. melting rate.

furnaces. As example of this, Fig. 5 shows the oil-fired furnace of Prof. Wüst. This furnace is a combination between a reverberatory furnace and a cupola. The furnace has the oil

burner on one side, whereas on the other side a shaft is mounted. The flame of the burner passes over the bath and meets at the other end the lower part of the charge of the shaft. When the charge starts to melt, the liquid iron runs into the bath. The gases which leave the shaft have to pass through a preheater and

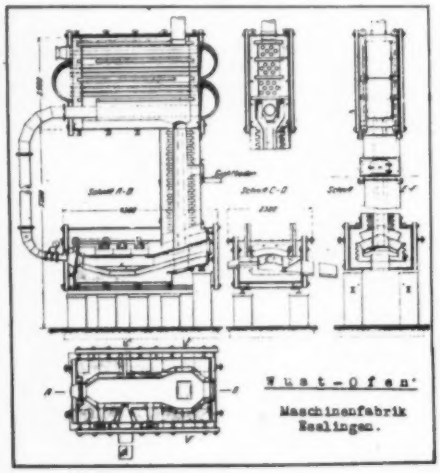


Fig. 5.—The Wüst Furnace is a Combination of the Cupola and Air Furnace. "Gichtboden" is the Charging Door.

the air for the oil burner is in this preheater heated up to 400 deg. C. The charge is put in the shaft with 2 per cent. of limestone, but without coke. The product of the Wüst furnace excelled in its low-sulphur and low-carbon contents and the exactitude of the desired analysis.

The Brackelsberg Furnace.

In recent years another furnace, the Brackelsberg furnace, has been quite a success. Fig. 6

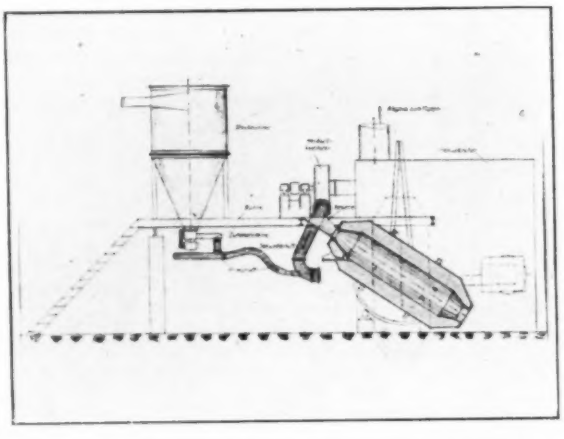


Fig. 6.—The Brackelsberg Furnace, showing the General Lay-out.

The furnace has been dealt with on several previous occasions in our columns.

gives a general idea of this furnace with air-preheater. The furnace consists of a drum of sheet iron, which is carried on rollers and lined. The standard furnace has a capacity of 6 tons, a length of 5 metres and a diameter of 1.20 metres. At the one end the burning coal dust enters the furnace; the gases escape in the middle of the other end through an opening into a recuperator. The opening at the burner end serves at the same time for the charging. For this purpose the furnace is tilted and the charge is put into the furnace over a shoot. This position is shown in the illustration. The gases pass through a preheater in which the air is preheated, which is necessary for the combustion of the coal dust. It is very important that the coal dust must flow absolutely evenly. The tap hole for the iron is placed at the burner end, beneath the burner, whereas the slag is blown out when the furnace is tilted for the new charge. The turning of the furnace requires a motor of ½ h.p., the high pressure fan 12 h.p. The pressure of the blast reaches 13.7 in. water.

The operation of the Brackelsberg furnace is as follows: The flame, which is directed towards the top of the furnace, fills the entire furnace. The ashes from the coal dust escape with the gases, and it is claimed the sulphur of the coal also leaves completely with the gases. Immediately after the charge starts to become liquid the furnace is rolled backwards and forwards several times for the purpose of heating the charge evenly to get a better efficiency. The flame is neutral, therefore there is but little oxidation. As soon as the charge is liquid, limestone is added to ensure a cover of slag. The iron in the Brackelsberg furnace does not take up gases and oxides. The main properties of an iron of the Brackelsberg furnace are so that there are no blowholes, no gas inclusions; the iron runs very fluidly and is absolutely quiet in the ladle and in the mould. The results of the different tests which have been obtained of the Brackelsberg furnace are remarkable; carbon, 2.5 to 3 per cent.; transverse strength, 54 tons per sq. in.; deflection, 0.78 in., are considered to be average figures. Fig. 7 shows a cast of sewing-machine parts. They are only about 0.08 in. thick, and the cast is always perfect. The cost of production of castings with the Brackelsberg furnace is claimed to be lower than those of the cupola. Very good results have been obtained also with the Brackelsberg furnace for non-ferrous metals; it seems to be very probable that this furnace has a good future.

Fig. 8 shows a comparison of the costs of production of liquid iron of high temperature for high-quality castings, molten in different furnaces. The improved cupolas, like the Schürmann cupola, will give results such as are shown under No. 2. It also shows how favourable the conditions seem to be with the Brackelsberg furnace.

Progress has also been made in the last years in the equipment of the moulding floor. The consolidation of sand began with hand-ramming; then pneumatic ramming; hand-squeezing; power-squeezing; jarring; centrifugal sand-throwing, and throwing the sand by compressed air. There are many different German moulding machines on the market now, as was shown at the recent foundry exhibition in Düsseldorf. The new Tabor machine and the Nicholls moulding machine are also highly appreciated. The sand-slinger has found its way into many foundries. In Germany recently the Axmann sand-slinger has been quite a success. This machine, which is called "Simplax," is a combination of a sand-slinger and a sand-cutting machine. The

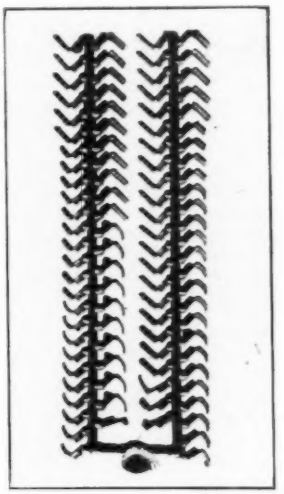


Fig. 7.—Castings from the Brackelsberg Furnace of High-Strength Iron, with 2.7 per cent. C.

machine is not expensive and it covers a large area.

Fig. 9 shows the new sand-slinger of the "Badische Maschinenfabrik, in Durlach." In this machine compressed air is used for the delivery and the compression of the sand. The mixing of sand and air takes place in a special container, out of which it passes in a continuous stream through a hose into the nozzle. There every particle of sand receives

Fig. 8.—The Production of High Temperature in various Furnaces and the Relative Cost.

No. 1 refers to the ordinary cupola (12s. per ton and 1,300 deg. C.); No. 2, well-conducted modern cupola (12s. and 1,500 deg. C.); No. 3, ordinary air-furnace (17s. and 1,500 deg. C.); No. 4, oil-fired reverberatory furnace (20s. and 1,500 deg. C.); No. 5, Wüst furnace (20s. and 1,600 deg. C.), No. 6, regenerative furnace (22s. and 1,650 deg. C.); No. 7, Brackelsberg furnace (15s. and 1,700 deg. C.), and No. 8, electric furnaces (from 18s. to 42s., depending on the price of electricity, and 1,800 deg. C.). The indications given on the top right high side, reading downwards, are: Temperature for high-quality iron; minimum temperature for malleable iron, and melting point of irons.

the same velocity and the sand is separated from the air.

Sand Research.

Sand-slingers are not used in Germany so much as in the United States. It seems that the German foundries do not have the right kind of moulding sand at their disposal. This

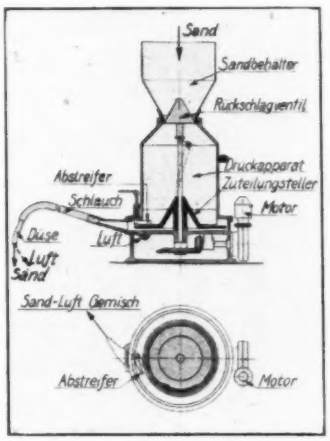


Fig. 9.—The Badische Compressed-Air Sand-Ramming Machine.

As the sand leaves the nozzle (düse), the air (luft) takes a different direction.

and certain other difficulties, which arose when higher capacities of the moulding machines were needed, called the attention of the Foundry Associations to the question of the properties of good moulding sand. Heretofore, empirical methods for the control of moulding sands were generally in use, now after several years of intensive research work definite results have been obtained. Prof. Dr. Aulich, whose work was financed by the German Foundry Owners' Federation, has made a careful survey of all known moulding-sand deposits in Germany. He classified the sands and compiled a map of Germany with all the distributions of sand. Then he used a very simple process to determine the amount of clay and size of the grain of the sand. The sand was first put in boiling water and the clay removed; then the remaining sand was dried. The dry sand was then passed through a number of different sieves made from silk. He standardised them into nine different classes:—

Fine green weak, fine green medium, fine green strong, medium green weak, medium green medium, medium green strong, coarse green weak, coarse green medium, and coarse green strong. All the moulding-sands in Germany are now classified in this way. Then Dieter's instrument, which Prof. Aulich changed somewhat, is used to test the compressibility and the porosity. For practical work in the foundry this method allows one to run a reliable test in ½ hr.

Quite recently the Association secured the co-operation of all the personalities and associations that were interested in the testing of moulding-sand. The object of their co-operative work was to find ways and means to enable every foundry to get the correct kind of sand for its work in the cheapest way possible, and, additionally, to advise the foundries how to make the best use of the sand.

Fettling Conditions.

For many years there has been little or nothing done for the fettling department. The use of pneumatic tools is now well established. The sand blast has been in Germany especially improved by the constant work of the well-known firm of Alfred Gutmann. Recently high-pressure water is used by several foundries for the cleaning of larger castings. This method was first used in the United States. The firm of Lanz developed this method in a special way, which is shown on Fig. 10.

Fig. 11 shows a very simple design of the sliding roof. The tubes, which are about 6 ft. long, carry spraying nozzles. One nozzle is straight, the other is bent to an angle of 90 deg., so that the water may reach every corner of the castings. This is facilitated by the turntable. The operator controls the cleaning from the outside. The mud is collected in a pit and is pumped at once into mud-cars. In these cars the sand sinks to the bottom; the different cars are connected with each other and the overflowing water runs into a pit. The hydraulic installation works with 65 atm.

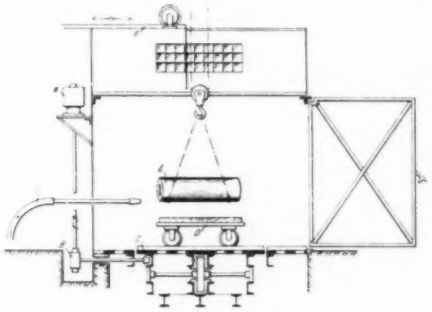


Fig. 10 shows the High-Pressure Water System of Fettling as developed by the Lanz Concern.

(about 1,000 lbs. pressure). By throttling, the pressure can be incrementally reduced down to 25 atm. To go below 20 atm. is not advisable. The size of the holes in the nozzles has been tried out, and it was found that with 0.2 in. nozzles and 50 atm. the best relation between cost of water and wages exists. Of course, sand-blasting cannot be replaced everywhere by wet cleaning; especially will lighter castings always be cheaper cleaned by the sand blast, but heavy-cored castings, especially those made in dried moulds, are suited for wet cleaning.

Unified Costing System.

All the different improvements which have been made in melting methods in the furnaces, in machinery, etc., have been very important for the development of the foundries. Aside

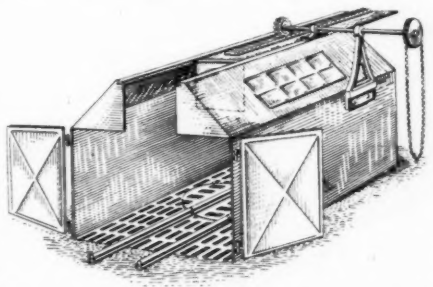


Fig. 11.—A Sliding Roof allows the easy Handling of Large Castings.

of this more technical development, the German foundries were forced to make essential changes in their organisation. The steps taken in this direction have led to a remarkable success. It was started with the advice given to the different foundries to specialise as much as possible; that means to cut down their programme of work to those castings which are really best suited to them and to as small a number of different articles as possible. Then all the methods to control the material were studied and given to the foundries in the simplest form. The next step has been the analysis of the different operations in the foundry. In former years most of the foundries took on all types of work that was offered to them. Now they try to get the foundries of a certain district together and to distribute the orders to the foundries according to their capacity. The success so far obtained is promising. Naturally, it was necessary to compare the cost of production in the different foundries with each other. No less than 150 foundries were picked out to figure on a number of castings, when the first results were received, it was found again that the difficulties which exist in getting the correct cost are greater in foundries than in almost any other branch of the industry. In foundries the products vary very much, and the method of producing a casting is largely dependent upon the individual viewpoint of the man-in-charge. Another point which makes it difficult for foundries to come to a uniform calculation is the fact that there are a great number of small foundries. These foundries have very often no, or not very much of, a commercial department. Therefore, it was decided to issue principles of calculation in foundries. The so-called "Harzburger Druckschrift" memorandum was published ten years ago. Even if this memorandum did not answer every question, it made every other method of calculation disappear in Germany, and it has, therefore, been a great forward step. After the issue of the first publication it has run into four editions. Each brought slight changes, but the main principles have not been changed. The German Foundry Employers' Federation has now, in addition to the memorandum, published the so-called "Kalkulationsbeispiele," or examples of calculation. A typical one is shown (Fig. 13). These forms are used in the actual foundries. The figures, which have been found by actual practice, are reported from

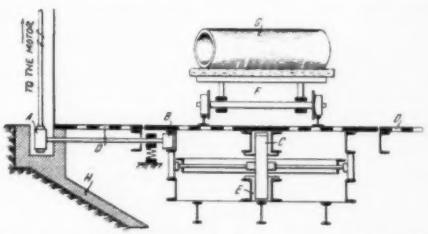


Fig. 12.—A Turntable Manipulated from the Outside brings each Face of the Casting opposite the Operator.

time to time to the secretary of the organisation. The first compilation of figures is now ready, and after some time it will be possible to give to the members a valuable collection of a very large number of calculations. It is hoped that this will help to educate the foundries towards correct costing.

The main points of costings are next to the cost of liquid iron, the wages and the overhead costs. For the correct determination of the overhead costs a special committee has been working for three years on a model system of book-keeping. The committee has been working in close collaboration with the Imperial Committee on Economy. The volume with the title "Einheitsbuchführung für mittlere Eisengiessereien" standardised book-keeping for foundries of medium capacity and was published about a year ago. This book has been bought by very many foundries, and it is to be hoped that this will also lead to an improvement in the method of costing.

Time Studies.

For "time-studies" in the foundry, the German Foundry Owners' Federation appointed a committee which followed also the lines enunciated by the Imperial Committee for the determination of labour-time: "Reichskuratorium für Arbeitszeitermittlung." The Imperial Committee used an abbreviated name, "Refa"; it has issued a number of forms in which the different terms necessary for the studies are explained, and they also give advice to those who

XUM

desire to institute time-studies. It was not possible to follow too exactly the methods utilised in the United States. The result of the time-studies has been, in every case, a reduction of wasted time and an increase in the output of the workmen without increased fatigue. One of the younger foundrymen in Germany, Mr. Tillmann, has specialised on this work, and he is often called into foundries to study the conditions and give his advice. In one of his lectures he reported, for instance, on the moulding of a disc-coupling. The time needed was initially 7.73 min. By excluding wasted times the time went down to 7.01 min., then, by changing the sequence of operations and by installing a handy moulding-bench, the time was reduced to 5.57 min. The man was able to deliver 97 moulds in 9 hrs. against 62 previously.

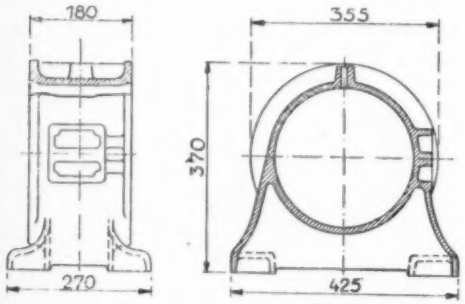
With small work on moulding-machines savings of 25 per cent. were gained; if those castings were made on an automatic moulding-machine another 15 per cent. was saved, and by changing a pattern from core-moulding to a design with ribs, a further 26 per cent. was gained. Bearings weighing 42 lbs., which had to be made in series, the time saved in moulding by using the sand-slinger was 61 per cent.; in core-making, by using oil-sand, 69 per cent., and in the cleaning department 62.5 per cent. Table I shows how much can be gained even by small changes in the way of production. In this example finally only 35 per cent. of the original time was necessary.

Table I.—*Example of a Frame weighing* 4,000 *lbs.*

Frame weighing 4,000 lbs.		Time needed.
1st Method—	Floor moulding, hand ramming	100 per cent.
2nd „	Rammed with pneumatic rammer ...	90 „
3rd „	Made in special 3-part box. — Pneumatic rammer used ...	75 „
4th „	Pattern changed. — Moulded in 2-part box	62.5 „
5th „	As Method 4, but rammed by the sand slinger	35 „

The question of the education is deemed of paramount interest, not only of the apprentices but also of the foundry technical force. Together with the Imperial Committee for Technical Education the German Foundry Owners' Federation published a programme for the apprenticeship of moulders. This is to be used by the professional schools to give a uniform education to the apprentices. It has always been difficult to get enough apprentices for foundries, but in recent years the difficulties are far greater on account of the dropping-off of the birthrate during the war. The Federation has published a little booklet under the title "Shall I Become a Moulder?" in which the main objections against the profession of a moulder are treated. This little booklet has been very valuable, and other countries that have the same difficulties have asked permission for translation.

It is hardly possible to give a complete report on the progress foundry-work has made in the last years because every part of the work in foundries has partaken of the new development. For instance, the new methods in the testing of materials, X-ray testing, testing the hardness and the machinability, the new methods of pyrometrical tests: these and all the new instruments which have been brought out to control the equipment, all have had their share in improving the quality and decreasing the cost of production of castings. But the author hopes to have given in his Paper an idea of the work that has been done to advance the foundry industry. As an important necessity in this direction the co-operation of the different nations and the exchange of experiences are essentials.



Hand-Moulded Casting.

Type of casting: Motor housing.

Quantity: 1 off.

Weight: 25 kg.

Casting-box: Size 500 × 500 × 150/200/150 mm.

Pattern: Two-parted wooden pattern.

Mixture:	50	kg. Hematite	RM.	for 100 kg. RM.
	50	kg. No. 3 Foundry	RM.	„ 100 kg. RM.
	5.4	kg. 2 pieces Silicon Alloy	RM.	„ 100 kg. RM.
	214	kg. Domestic Scrap... ...	RM.	„ 100 kg. RM.
	100	kg. Machinery Scrap ...	RM.	„ 100 kg. RM.
				RM.
				for 100 kg. RM.
				Melting cost RM.
				RM.

Liquid iron according to the Harzburger Memorandum ... ... RM. for 100 kg.

Piece-work time	Minutes	Minutes	Minutes
Moulder			
Coremaker			
Fettler			

Works Costs ... ... %
Overheads ... ... %
Profits and Risks ... ... %

Remarks: This casting is moulded in green sand in a 3 part box.

The average hourly earnings in RM. in this work were, on 1.5.27:

Moulder ... ... RM. 1.05
Coremaker ... ... RM. 0.98
Fettler ... ... RM. 1.03

Fig. 13.—A Typical Example of a Data Sheet Evolved as a result of Co-operative Study.

Some Technical Aspects of the Electric Steel Foundry.

(*Continued from page* 271.)

which have been annealed at the proper temperature, with requisite soaking and appropriate cooling, will show the desired refinement of grain.

The maximum refinement of grain with increase in tensile strength may be had by accelerating cooling. The usual method of hastening cooling is to draw the furnace truck out of the furnace and cool in air. But in castings showing irregularity in design this is not too safe a proceeding, and if practised the casting should be returned to the furnace on reaching about 600 deg. C. and allowed to finish cooling with the doors shut.

The design of the large majority of steel castings preclude the use of oil or water quenching, with subsequent tempering treatment. But on the few occasions the author's firm has been asked to supply castings so treated it has been found that electric steel responds well to this type of treatment. A close approximation of the physical properties obtainable by the quenching treatment may be had by heating the castings to above Ac3, and air-cooling to just below Ar1, reheat to about 680 deg. C. and maintain at this temperature until heated through, and allow to cool in the furnace; further, whilst raising the tensile strength, it does not greatly impair ductility and machinability. Generally speaking, castings which have had a full annealing with furnace cooling will show some reduction in tensile strength, with increased ductility, reduction in area and bend. Air cooling increases the tensile strength and elastic limit, with little reduction in ductility and bend.

Table III outlines tests made by the Sheffield Testing Company on customers' electric-steel castings.

Table III.—*Tests from Electric Steel Castings.*

Max. S. tons/sq. in.	E. per cent. in 2 in.	R.A. per cent.	Fracture.	Bend.
30.04	33	39	Silky fibrous	180°
32.90	32	35.6	Fibrous ..	180°
31.78	40	52.4	Silky fibrous	180°
41.40	24	33.8	Fibrous ..	110°
44.40	19	25	Fibrous ..	100°

In concluding this Paper, the author would like to express his indebtedness to Messrs. Head, Wrightson & Company for allowing him to use data obtained from the foundry for compiling it, and also to thank his colleagues on their staff who have assisted him with information and helpful criticism.

Chrome-Nickel Steels.—One of the most notable metallurgical advancements of the past two years is the introduction of corrosion-resistant steels, says the "Iron Trade Review." The new alloys are of the chrome-nickel type, and are not to be confused with "stainless steels" available for several years. Composition and properties of the two types are distinct, each having its particular field of usefulness. Chrome-nickel steel contains about 18 per cent. chromium, 8 per cent. nickel, and up to 0.20 per cent. carbon; the typical stainless steel contains from 12 to 14 per cent. chromium and 0.28 to 0.38 per cent. carbon. The latter is excellent for cutlery, but does not possess the necessary resistance to corrosion that highly alloyed steels do. The chrome-nickel alloys have a tensile strength in the soft state of about 100,000 lbs. per sq. in., and this is retained at elevated temperatures. Oxidation is resisted at high temperatures. Although the alloy does not lend itself to hardening by heat treatment, the hardness and strength can be increased by cold work. The material can be welded and is available in nearly all forms, is easily workable, and can be drawn into wire and piping and deep-drawn into a wide range of shapes. One general trade name frequently embraces many makes, each of a different composition; one such product is sold under between 20 and 30 names, and this has led to considerable confusion. Acceptance of the new chrome-nickel alloys will be more general and more rapid when this confusion has been clarified.

STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Standard Shatter Test for Foundry Coke.

The Midland, Northern and Scottish Coke Research Committees have adopted, and advocate, the following standard method for the shatter test:—

Apparatus.

The shatter-test apparatus* shall consist of a box 18 in. in width, 28 in. in length, and approximately 15 in. in depth, supported above a rigidly mounted cast-iron or steel plate, not less than ½ in. in thickness, and not less than 38 in. in width and 48 in. in length. The inside of the bottom of the box when in its highest position shall be 6 ft. above the plate. The bottom of the box shall consist of two doors hinged lengthwise and latched so that they will swing open freely and not impede the fall of the coke. Boards about 8 in. in height shall be placed around the plate, so that no coke is lost. To minimise the breakage of coke, which might

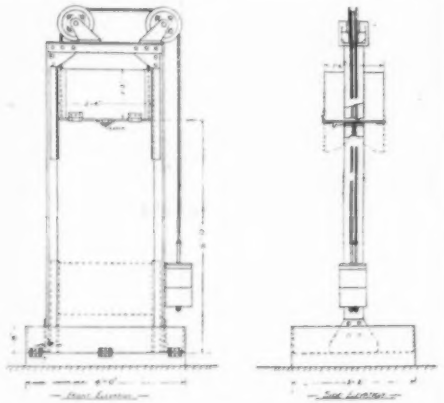


Fig. 1.—Diagram of the Shatter-Test Apparatus.

otherwise occur while placing the sample in the box, the box shall be so suspended that it can be lowered to a convenient level for filling. Convenient forms of shatter-test apparatus are shown in Figs. 1 and 2.

Screens.

For determining the breakage of the coke sample, square-mesh screens with the following openings shall be used:—2 in., 1½ in., 1 in. and ½ in. These screens should be machine stamped from mild-steel plates† with a limit of error of ±⅛ in.

Procedure.

Fifty pounds‡ of coke, all over 2 in., shall be placed in the box of the shatter-test apparatus, the coke levelled, the box raised, and the coke dropped on to the plate. The box shall be lowered and all the coke shovelled into it indiscriminately, but taking care to avoid breakage. The box shall then be raised and the coke again dropped. When the coke has thus been dropped four times in all, it shall be screened by hand in such a way that any piece which can pass through the screen in any position shall be counted as undersize, and the weights of coke of each grade shall be determined to the nearest ounce.

* The essential dimensions of the Shatter Test apparatus are those given by the American Society for Testing Materials in "Standard Method of Shatter Test for Coke," Serial Designation: D141-23 (A.S.T.M. Standards, 1927, Part II, Non-Metallic Materials, p. 571).

† Obtainable from Messrs. G. A. Harvey & Co. (London), Ltd., Woolwich Road, London, S.E.17.

‡ If for any reason the shatter test cannot be made with a true average sample of the original coke over 2 in. the grading of the coke taken for shatter test should preferably be such that the weight-ratio of the 4-in. 3-in. and 2 in. grades is that found in a preliminary size-analysis of the original coke.

Results.

At least three tests shall be made, and the results stated as percentages (given to one decimal place) remaining on 2-in., 1½-in., 1-in. and ½-in. screens. The shatter indices reported shall be the average values of the percentages retained on the 2-in. and 1½-in. screens, and shall be given to the nearest whole number only. A single figure shall be understood to be the 2-in. index, unless otherwise stated. In future the 1½-in. figure shall invariably be given in addition to the 2-in. figure by stating the shatter indices in the form 71/86, where the figures are the 2-in. and 1½-in. indices respectively.

Where possible, the statement of the shatter indices shall be accompanied by a brief description of the coke; for example, as "blocky coke," "prismatic coke," "narrow oven coke," "compressed-charge coke" and "beehive coke."

Fig. 2.—The Shatter-Test Apparatus.

Tolerated Deviation.

If the average deviation of the individual results from their average exceeds 3.0 and 2.0 at the 2-in. and 1½-in. screens respectively, the corresponding shatter indices shall be marked with an asterisk, and, if it is desired to base any conclusion or to take any action upon the result, a further series of at least two tests shall, if possible, be made and the results thereof averaged with those of the original series.

Iron and Steel Literature in 1929.—The Carnegie Library of Pittsburgh has reprinted from the "Blast Furnace and Steel Plant," and issued in pamphlet form a classified list of the more important books, serials and trade publications during 1929.

Corrosion-resisting Cast Iron.—M. Ballay has investigated the microstructure and resistance to corrosion of 15 different cast irons containing up to 15.6 per cent. Ni, 6.5 per cent. Cu, and 2 per cent. Cr. The most resistant of those tested was that containing 2.16 per cent. Si, 15.63 per cent. Ni, 5.76 per cent. Cu, and 1.28 per cent. Cr; this withstood cold dilute mineral acids, acetic acid, and sea-water as well as, or better, than a good bronze, but was more readily corroded by hot sulphuric acid. The iron has an austenitic structure, is easily worked, and does not scale badly at high temperatures.—"Revue de Métallurgie."

Iron and Steel Institute.

The Annual Meeting of the Institute will be held at the Institute of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, May 1 and 2 next.

THURSDAY, MAY 1.

The general meeting will open at 10 a.m., when the annual report and statement of accounts for 1929, will be presented. Election of new members will follow. Further items of the agenda are:—(1) To confirm amendment of Bye-law 10, namely: to delete in line 1 of the existing bye-law the words "The President shall be elected for one year" and to insert in place thereof the words "The President shall be elected for two years and shall not be eligible for re-election until after an interval." (2) Presentation of Bessemer gold medals to Mr. Eugene Schneider, Sc.D., and to Dr. W. Rosenhain, F.R.S.

Papers Nos. 4 and 2 (see appended list) will then be presented for discussion.

At 2.30 p.m. the afternoon session will commence, and Papers Nos. 13, 10, 6 and 8 will be presented for discussion.

In the evening, at 7 for 7.30, the annual dinner of the Institute will be held in the Grand Hall, Connaught Rooms, Great Queen Street, W.C. Applications for tickets (price 15s. each, excluding wine), should be sent in not later than April 24.

FRIDAY, MAY 2.

At 10 a.m. the general meeting will be resumed. An announcement of the award of the Andrew Carnegie Research Scholarships for 1930-31 will follow, as well as of the award of the Williams Prize to Mr. W. E. Simons (Cardiff); and Papers Nos. 1, 7, 3, 11 and 12 will be presented for discussion, while Papers Nos. 5 and 9 will be presented and discussed by correspondence.

Papers to be read at the Meeting.

(1) "Some Alloys for Use at High Temperatures. Nickel-Chromium and Complex Iron-Nickel-Chromium Alloys." Part I.—By W. Rosenhain and C. H. M. Jenkins. Part II.—By C. H. M. Jenkins, H. J. Tapsell, C. R. Austin and W. P. Rees.

(2) "Developments in Fuel Economy at Skinningrove," by F. Bainbridge.

(3) "Carburising and Graphitising Reactions between Iron-Carbon Alloys, Carbon Monoxide and Carbon Dioxide," by M. L. Becker.

(4) "An Experimental Inquiry into the Interactions of Gases and Ore in the Blast Furnace. Part II.—Carbon Deposition at 450 deg. C. and its Influence upon the Ore Reduction; Equilibria between Gases and Ore at 650 deg. to 1,000 deg. C.," by W. A. Bone, L. Reeve and H. L. Saunders.

(5) "The History of the Cementation Process of Steel Manufacture." Part I.—By D. Brownlie. Part II.—By Baron de Laveleye.

(6) "The Metallography of some Ancient Egyptian Implements," by Sir H. C. H. Carpenter and J. M. Robertson.

(7) "Alloys of Iron Research. Part IX.—"The Constitution of the Alloys of Iron with Silicon," by J. L. Haughton and M. L. Becker.

(8) "Chromium-Copper Structural Steels," by J. A. Jones.

(9) "The Corner Ghost in Steel Ingots," by S. Maita.

(10) "Tin and Sheet Mill Rolls. Their Treatment, Performance, and Premature Failure in Service," by E. Mort.

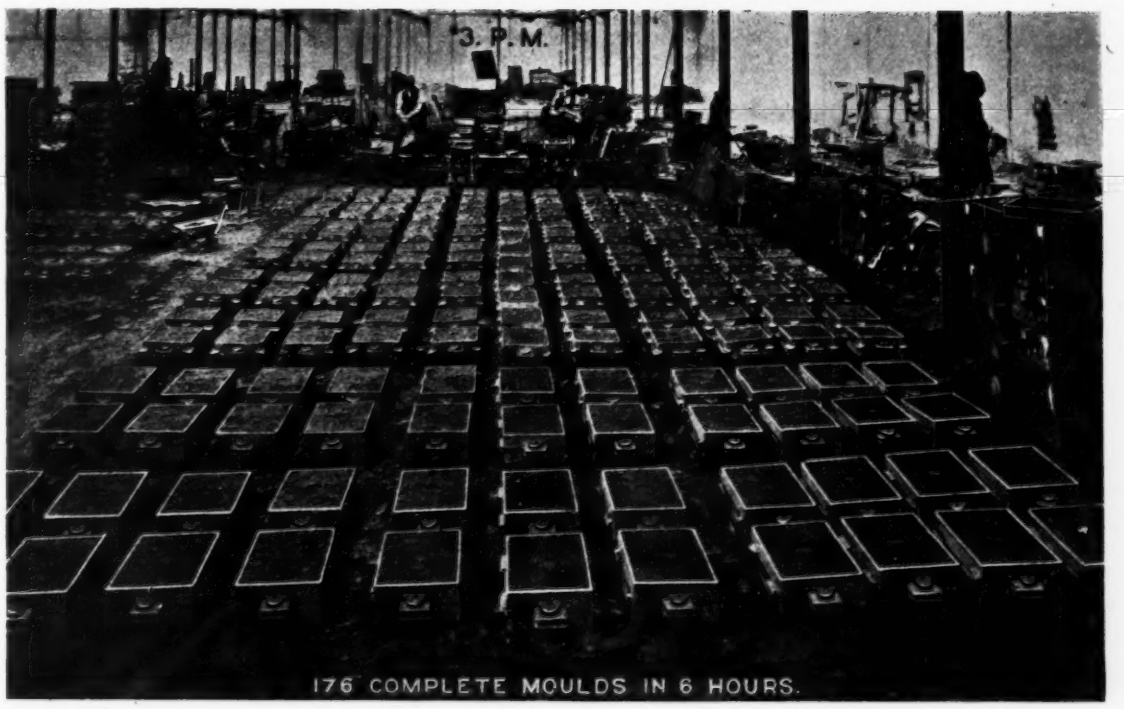
(11) "The Effect of Melting Conditions on the Microstructure and Mechanical Strength of Grey Cast Irons containing Various Amounts of Carbon and Silicon," by A. L. Norbury and E. Morgan.

(12) "The Properties of some Steels containing Chromium," by A. R. Page and J. H. Partridge.

(13) "Single-Sheet or Thin-Pack Normalising, or Heat Treatment *versus* Box-Annealing of Sheets," by R. Whitfield.

DO YOU GET THIS OUTPUT IN YOUR FOUNDRY?

MACHINES ARE MOVED FROM STACK TO STACK OF BOXES ALONG RAILS AS SHEWN



176 COMPLETE MOULDS IN 6 HOURS.

THE ABOVE ARE ACTUAL PHOTOGRAPHS OF A DAY'S PRODUCTION FROM OUR MACHINES IN OUR FOUNDRY.

Full particulars and prices:

DENBIGH ENGINEERING Co. Ltd.

TIPTON, STAFFS.

Telephone: 334-335. **Telegrams: "DENBIGH, TIPTON."**

AUSTRALIAN AGENTS:—McPHERSON'S PTY., LTD., Melbourne, Adelaide & Sydney.
NEW ZEALAND AGENTS:—JOHN CHAMBERS & SON, LTD., Auckland, Wellington, Christchurch & Dunedin.

Trade Talk.

Messrs. Daniel Adamson & Company, Limited, announce the removal of their London office to 16, Northumberland Avenue, W.C.2.

Messrs. William Beardmore & Company, Limited, Dalmuir, have received from the Northern Lighthouse Commissioners an order to build a twin-screw steamer.

Mr. A. Hanbury Sparrow, iron manufacturers' agent, 62, Dale Street, Liverpool, retired from business on March 31. Mr. H. Newton Hale succeeds him in the business.

Messrs. Hughes, Bolckow & Company, Limited, North Blyth, have purchased the cargo steamer "Thespis" from Messrs. Lamport & Holt, Limited, Liverpool, for breaking up.

Messrs. Parson, Limited, iron and steel merchants, 111, New Street, Birmingham, have purchased the goodwill of the Birmingham branch of Messrs. Parson & Crosland, Limited, and have taken over the assets and liabilities of this branch.

Contracts have just been let for an extension to the main machine shop at the Coventry works of Messrs. Alfred Herbert, Limited. The shop at present consists of 23 bays. Four new bays are to be added, making the total area of the extended shop 8.37 acres.

Messrs. George Walker, Sons & Company, 116, Hope Street, Glasgow, have taken over the business of iron and metal merchants carried on by the late Mr. David A. Jobson at 10, Guthrie Street, Dundee, and will continue the business at the same address.

It is reported that Messrs. Bernard Hinds & Company, Limited, constructional engineers, of Morriston, have secured the contract for erection and engineering work in connection with the completion of the new "cracking" plant at the National Oil Refineries, Skewen.

As from April 14, the Birmingham office address of the Metropolitan-Vickers Electrical Company, Limited, will be "Wellington House," 39, Bennetts Hill, Birmingham. The telephone numbers are Central 2801 and 2802, whilst the telegraphic address is "Multiphase, Birmingham."

One of the schemes approved by the Government for the relief of unemployment includes the construction of a dredger for the Wear, and the contract for the work has been secured by Messrs. Priestman Brothers, Limited, of Hull. The dredger is to be of the side-charging grab hopper type.

The English Steel Corporation, Limited, have secured orders from the Continent for 74 forged-steel boiler drums and also a large order for forgings for turbine rotors. The work will mean the making of 5,000 tons of steel ingots. The orders will be executed at the River Don Works, Sheffield.

Various electricity undertakings have placed orders for a total of twelve Foster economisers since the beginning of this year. In addition, orders have been received for 24 installations abroad. The Foster economiser is manufactured at the Wakefield works of Messrs. E. Green & Son, Limited, for Eco Power, Limited, London.

The joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board have been informed by Sir John M. MacLeod, Bt., that he has examined the employers' books for January and February, 1930, and certifies that the average net selling price brought out is £10 9s. 9.07d. This means that there will be no change in the wages of the workmen.

Messrs. John Brown & Company, Limited, have received orders for a total of 25 seamless hollow forged drums, required for Stirling high-pressure boilers in connection with the super-power station at Thornhill of the Yorkshire Electric Power Company, Limited, and the extension of the Sheffield Corporation boiler installation. The total value of these orders is over £25,000.

Messrs. Bradley & Foster, Limited, announce that they can now supply West Coast refined pig-irons. They have acquired the West Coast Refinery at Cleator, Cumberland, and by retaining the original management and methods of manufacture will maintain the West Coast high standard of quality. "Dent" is the brand name of the iron, and it will be supplied in all the usual grades required for the manufacture of white-heart malleable castings. Full descriptive literature will be available shortly.

Messrs. Douglas Elliot & Company, Limited, iron and steel merchants, Leeds, have appointed Mr. J. A. Hayhurst as their outside representative in the Midland Counties from April 1, 1930. Mr. Hayhurst was previously on the staff of the Metropolitan Cammell Carriage, Wagon & Finance Company, Limited. It is interesting to note in passing that the business of Messrs. Douglas Elliot & Company, Limited, was founded by the late Mr. Douglas Elliot considerably over half a century ago, and two of the present directors, Mr. H. Illingworth and Mr. H. S. Hutchinson, have a combined service with the concern of 73 years.

A contract for the water-driven turbo units and automatic switchgear for the Shannon River Power Station has been placed by the Hydro-Electric Department, Tasmania, with Siemens (Australia), Proprietary, Limited, Sydney, as agents for the English Electric Company, Limited, London. The new station will contain two 7,250-h.p. reaction turbines direct coupled to three-phase alternators, each set being provided with a direct-coupled exciter, as well as an auxiliary generator for operating the switchgear control circuits and automatic devices. The switchgear for controlling these two units will be entirely automatic in operation, with the exception of the actual starting up and synchronising, and the station will run unattended. The water turbines and alternators, including main valves, governor gear, etc., will be manufactured partly at the English Electric works in England and partly by the Clyde Engineering Company, Limited, Sydney. The switchgear will be designed and manufactured by the English Electric Company, Limited, at their Stafford works.

Personal.

Mr. R. M. Scott, yard manager in Messrs. Henry Robb & Company's shipyard, Leith, has been appointed a ship surveyor to Lloyd's Register of Shipping.

Mr. G. E. Suter, who has been manager of the constructive department of Portsmouth Dockyard for the past 10 years, retired on March 31. He is succeeded by Mr. J. C. Joughin.

Mr. G. H. Haley, managing director of E. & W. H. Haley, Limited, ironfounders, Thornton Road, Bradford, has been elected a member of the Shipley Council in the Conservative interests.

Mr. H. G. Sommerfield has been returned a member of the Finchley Council, where for several years he has rendered stirling service as the chairman of Finance Committee. At the annual meeting of the Foundry Trades Equipment and Supplies Association he was elected a vice-president. This was unaccountably omitted from our report of the meeting, and we apologise for the *lapsus memoriæ*.

Sir Arthur Balfour, Bt., and Mr. H. Snell, M.P., have been appointed by the Prime Minister representatives of the Government on the Imperial Economic Committee, in succession to Sir Algernon Firth, Bt., and Mr. J. S. Wardlaw Milne, M.P., who have resigned. Sir Arthur Balfour is the head of the firm of Sheffield steel manufacturers which bears his name. He was chairman of the Committee on Industry and Trade appointed by Mr. Ramsay MacDonald when Prime Minister in 1924.

Wills.

Clegg, Mr. E., for 62 years associated with Platt Bros. & Company, Limited, machinery manufacturers, of Hartford Works, Oldham £15,919

Obituary.

Mr. James Harold Howard, J.P., of Messrs. James & Fredk. Howard, Limited, agricultural engineers and ironfounders, of Bedford, died recently, aged 72.

Mr. George Butler Lloyd, deputy chairman of the Sentinel Waggon Works, Limited, died on Friday, March 28, at Shelton Hall, his residence near Shrewsbury.

Mr. James Hogarth, for many years one of the partners of the engineering firm of Messrs. J. & R. Hogarth & Company, Kelso, Scotland, died on March 26, aged 83.

New Steelworks for Russia.—According to a cable from New York, the Russian government has made a contract with Messrs. McKee & Company, of Cleveland, Ohio, for the erection of steelworks in the Urals with an annual output capacity of about 2,500,000 tons.

Reports and Dividends.

H. H. Vivian & Company, Limited.—Credit balance, £2,334; brought in, £1,409; carried forward, £3,743.

John Hetherington & Sons, Limited.—No dividend on the preference shares for the half-year ending March 31.

Stanton Ironworks Company, Limited.—Final dividend on the preference shares at the rate of 6 per cent. per annum.

Richard Thomas & Company, Limited.—The directors are unable to recommend the payment of the preference dividend due on April 31.

A. Reyrolle & Company, Limited.—Profit, £98,021; brought in, £78,892; dividend on the ordinary shares of 12½ per cent.; to reserve, £40,000; carried forward, £75,680.

Baldwins, Limited.—Profit, £352,042; brought in, £3,399; depreciation, £80,000; for special expenditure at collieries, £19,735; balance of discount on 6 per cent. first mortgage debenture stock issue, debenture interest, etc., £23,811; carried forward, £27,893.

Harland & Wolff, Limited.—Profit, after providing £300,000 for depreciation, £374,874; brought in, £107,558; dividend of 6 per cent. on the first preference shares, £192,000; written off investments, £115,675; income-tax, £42,509; carried forward, £132,307.

Merry & Cuninghame, Limited.—Trading loss for year, £15,742; debit balance brought in, £226,339; debenture interest accrued but unpaid, £21,869; provision for property and income tax previously made, not now required, £18,680; debit balance carried forward, £245,271.

Henry Gardner & Company, Limited.—Net profit for nine months to December 31, 1929, £91,305; brought in, £34,603; directors fees, etc., £14,037; staff pension fund, £1,377; dividend at the rate of 8 per cent. per annum; to reserve, £30,000; carried forward, £37,589.

Imperial Chemical Industries, Limited.—Net profit, £5,780,208; brought in, £108,807; to reserve, £529,020; preference dividend, £1,407,755; final dividend on the ordinary shares of 5 per cent., making 8 per cent. for the year, and a dividend on the deferred shares of 2 per cent.; carried forward, £350,923.

Millom & Askam Hematite Iron Company, Limited.—The directors have issued the accounts for the three months ended December 31, 1929, in order that the financial year should synchronise with that of the Alquife Mines & Railway Company, Limited. The balance at credit of profit and loss account, including £35,930 brought in, was at December 31, 1929, £63,953, from which is deducted debenture stock interest and redemption fund for three months, £2,325; depreciation reserve, £7,500; leaving £54,127, which is carried forward.

Company Meetings.

Kerr, Stuart & Company, Limited.—The annual meeting was held in London recently. Mr. H. L. Reed (chairman and managing director) said that the year under review had proved very difficult for the company. The conditions prevailing in the locomotive industry had continued to be so depressed that it had become impossible for the company to secure orders of any magnitude except at unremunerative prices. The normal output of the undertakings now manufacturing locomotives was estimated to be not less than 2,000 locomotives per annum, whereas the orders received in this country last year represented less than a quarter of that amount. As a result competition was very severe, and with prices at the present level it was impossible to get work at a figure that would show a profit. Continental competition remained acute. Indian orders to the extent of approximately £1,000,000 had been placed with Continental manufacturers at prices approximately 5 per cent. below those of British tenders. To meet this difference in price representations had been made by the industry in the proper quarter for some assistance, but so far there seemed little or no hope of any favourable response. This year the position had shown improvement, and the works were now working to nearly full capacity, but in view of the very restricted nature of inquiries it was impossible to foresee any hope of continuity of the present position, and he feared that in the near future they might be without any serious heavy locomotive work in hand. During the year the company had put on the market a 7-ton Diesel lorry, and this had met with considerable success.

Telephones:
SHEFFIELD 22311 (3 lines)
LONDON 1483 Central
GLASGOW South 1580
WORKSOP 205
AMBERGATE 7
STOCKSBRIDGE 27
GALSTON 49

"SERVICE BCM/GX FIRST."

MANUFACTURERS & PRODUCERS OF REFRACTORY MATERIALS OF EVERY DESCRIPTION
BRICKMAKERS · QUARRY AND MINEOWNERS CONTRACTORS & EXPORTERS.

GENERAL REFRACTORIES
LIMITED
Incorporating
THE GENERAL REFRACTORIES CO. LTD. THE MIDLAND REFRACTORIES CO. LTD
THOMAS BROOKE & SONS LTD WORKSOP BRICK CO. LTD. GUISELEY SILICA CO LTD.

Telegrams:
"GENEFRAX"
Sheffield
London
Glasgow
Worksop
Monomarks:
BCM/GX
BCM/ Magnesia
BCM/ Coroma
BCM/ Pyrolyte
BCM/ Insulite

KELHAM ISLAND MILLS SHEFFIELD · LOWGROUNDS BRICKWORKS WORKSOP · *Notts* · BULLBRIDGE BRICKWORKS AMBERGATE · *Derbys* · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · *Dur* · BRACKENMOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · *Ayrshire*
AND AT MANSFIELD, WARSOP, EBBERSTON, CORBRIDGE, BRAMCOTE, LUFFENHAM, TOW LAW, MONTGREENAN &c.&c.

LONDON OFFICE
20 Budge Row E.C.4. (M^r A.C. Turner)

Head Office
Wicker Arches, SHEFFIELD

GLASGOW OFFICE
82 Dale St. C.5. (M^r A.W. Montgomery)

"EXTRA STRONG YORKSHIRE SAND"

is highly concentrated and will carry more floor or mixing sand than any other sand in the World.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The one outstanding result of the recent price movement in the Cleveland iron market has been a revival of confidence in buying, both on home and export account, and consequently a gradual enlargement of business in the form of forward commitments. For many months past consumers have only been ordering just sufficient tonnages to satisfy more immediate necessities, but with the substantial cut in prices now in force, and quite expected to remain as fixed for some time to come, buyers are now encouraged to book in advance on a much heavier scale than was previously justifiable or judicious. More especially gratifying is the expansion in the Scottish trade. In this area competition has been very severe, and it transpires that French foundry iron is still offered at prices well below the delivered price of the Cleveland product. But at least the difference in the price of the two commodities has been reduced, and there are plenty of buyers in Scotland who are prepared to pay a small —but not a big—premium for Cleveland iron, which they are more used to handling. It may be noted in this connection that the increase in the shipments of pig-iron from 16,168 tons in February to 20,208 tons in March was almost entirely due to the heavier shipments to Scotland, to which destination 8,713 tons of local iron were shipped last month, as against 4,588 tons in February. Quotations both for home sales and for export are:—No. 1 Cleveland foundry, 70s. per ton; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

Competition in the market for East Coast hematite continues with unabated keenness, and prices consequently are steadily declining week by week. The opinion is gaining ground that output will have to be curtailed, and possibly steps will have to be taken to end a form of cut-throat competition which is forcing prices far below the cost of production. Prices vary considerably, makers quoting 75s. to 76s. for mixed numbers, with No. 1 quality at 6d. premium. On the North-West Coast the quotation for Bessemer mixed numbers is 76s. to 79s. per ton at works.

LANCASHIRE.—Consumers of foundry pig in this area, in expectation of an early price movement to their advantage, are reserving buying until the Midland furnaces disclose their intentions with regard to this important question, which, it is hoped, will be on a scale similar to that of the Cleveland ironmasters. In the meantime business is restricted within narrow limits, with prices as previously reported. Derbyshire and Staffordshire No. 3 brands being quoted at 77s. and Scottish iron at 95s. per ton delivered local stations.

THE MIDLANDS.—Markets for foundry pig in the Black Country district are still somewhat inactive, while the supplying furnaces, owing to the slack demand, are beginning to accumulate stocks. No change in the position is, however, likely until the meeting of the pig-iron producers next month, unless anything is arranged on the occasion of the quarterly meeting in Birmingham to-day. Meanwhile, the following rates are quoted:—75s. for Northants No. 3, and 78s. 6d. for Derbyshire and North Staffordshire No. 3, including delivery to local stations.

SCOTLAND.—Business in the Scotch pig-iron market remains exceedingly quiet. In spite of this, the makers maintain their price at 78s. per ton for No. 3 foundry at the furnaces. Consumers are only buying their immediate requirements, in the hope that a reduction will be made, but the smelters give them no encouragement to expect concessions. Among the light-castings founders, business still remains exceedingly quiet, and three or four working days a week is the general experience.

Finished Iron.

With regard to the state of the manufacturing branches in the Black Country districts, nothing fresh has transpired since last reported, the market continuing dull and uninteresting so far as crown and the cheaper grades of iron are concerned. The makers of Staffordshire marked bars continue to be fairly well occupied, although, during the last fortnight, business has not been up to the previous standard. Marked bars are still quoted at £12 10s. at works. With regard to crown iron, local quotations are round about £10 5s., but from works outside the district crown iron is offered at down to £10 per ton. The price of nut and bolt iron is from £9 to £9 7s. 6d., but business is almost absent at these rates.

Steel.

The demand for semi-finished steel is irregular, and consumers appear to be limiting their purchases to their barest needs. A certain amount of business has passed to the Continent, but British makers have obtained a fair share of the transactions. In finished steel most of the business passing has consisted of small orders for near delivery, and the export markets, although inquiring more freely, have bought only sparingly. At Sheffield quotations rule as follow:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium, £7 12s. 6d. to £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; acid wire rods, £12 5s. to £12 10s.; basic wire rods, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11.

As a result of dearer raw material, higher charges for stainless steel for cutlery came into operation last week. The whole of the Sheffield makers have agreed to work to a revised and uniform scale of prices. In the tinplate market current quotations for coke quality remain steady at 18s. 3d. to 18s. 6d., net cash, f.o.b. Welsh ports.

Scrap.

Most of the markets reserved for foundry scrap material continue inactive, and as a rule running contracts—mostly negotiated at higher figures than those now ruling—seem to be ample for current requirements, while new sales are difficult to negotiate. At Middlesbrough ordinary heavy cast iron is still standing at 60s. per ton, but there is not much business, either in this or good machinery quality, the latter in handy sizes being offered at 64s. per ton. In the Midlands very little change has taken place in the market for cast-iron scrap. For machinery cast-iron scrap in handy sizes 67s. 6d. is realised, with 63s. 6d. quoted for heavy metal and 55s. to 62s. 6d. for light material. In Scotland the market for machinery cast-iron scrap is unchanged; for first quality 68s. 6d. to 70s. is quoted, with little business, and for heavy ordinary cast iron around 64s. Railway chairs are at 67s. 6d., light cast iron 58s. 6d. to 59s. 6d., and cast-iron firebars 56s. 6d. to 57s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Price movements in the markets for base metals during the past week disclosed generally an easier tendency, although without any substantial loss on balance at the close. American copper interests show no sign of an early change in policy, and are maintaining the price in face of the restrictive effect on the demand of the present high values. It is probable that they anticipate a forced buying movement on the part of consumers, who have held off the market for some time and whose stocks must, in consequence, be running low.

Closing quotations :—

Cash.—Thursday, £70 2s. 6d. to £70 5s.; Friday, £69 16s. 3d. to £69 18s. 9d.; Monday, £69 to £69 2s. 6d.; Tuesday, £69 5s. to £69 10s.; Wednesday, £68 to £68 5s.

Three Months.—Thursday, £68 5s. to £68 7s. 6d.; Friday, £67 17s. 6d. to £68; Monday, £67 to £67 2s. 6d.; Tuesday, £67 5s. to £67 10s.; Wednesday, £67 7s. 6d. to £67 10s.

Tin.—The publication of the March statistics, which were regarded as fairly satisfactory, brought little immediate improvement in the standard tin market, values closing lower at the week-end. This is probably due to the knowledge of the fact that there exist some heavy speculative commitments. Also there have been extensive sales by operators anxious to make a profit. Generally, however, the tone is more optimistic, although it is expected that irregular conditions will prevail for some time yet.

Official closing prices :—

Cash.—Thursday, £164 10s. to £164 15s.; Friday, £163 7s. 6d. to £163 10s.; Monday, £162 5s. to £162 7s. 6d.; Tuesday, £163 12s. 6d. to £163 15s.; Wednesday, £165 15s. to £166.

Three Months.—Thursday, £166 7s. 6d. to £166 10s.; Friday, £165 2s. 6d. to £165 5s.; Monday, £164 2s. 6d. to £164 5s.; Tuesday, £165 12s. 6d. to £165 15s.; Wednesday, £167 12s. 6d. to £167 15s.

Spelter.—Under the stress of over-production and low consumption the spelter market remains depressed, and prices have shown further weakness. There does not seem to be much chance of an improvement in the market in the near future. The galvanising industry remains depressed, and other consuming interests are not active.

Daily quotations :—

Ordinary.—Thursday, £18 5s.; Friday, £18 6s. 3d.; Monday, £18 6s. 3d.; Tuesday, £18 6s. 3d.; Wednesday, £18 3s. 9d.

Lead.—Very steady conditions have ruled in the lead market of late, and considerable sales have again been made, so that the recent falling-off is not surprising. A large tonnage was sold in March, and some reduction of the volume of demand might now be expected.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £18 17s. 6d.; Friday, £18 11s. 3d.; Monday, £18 3s. 9d.; Tuesday, £18 10s.; Wednesday, £18 7s. 6d.

Scottish Launches.

The cargo steamer "Knight Almoner" has been launched by Messrs. Lithgows, Limited, Port Glasgow. The vessel, which is a two-deck steel steamer, has been built for the Ottoman Line, Limited. She is 375 ft. in length, 53 ft. in breadth and 28 ft. in depth, and of approximately 4,500 tons gross.

Messrs. Workman, Clark & Company (1928), Limited, have launched the steamer "Musa," built for Messrs. Elders & Fyffes, Limited, London, for service between Central America and the West Indies. The vessel is 6,000 tons gross, the propelling machinery to be supplied by the British Thomson-Houston Company, Limited, Rugby. The installation will comprise a turbo-alternator, including a multi-stage super-efficient turbine of the Curtis impulse type, direct coupled to a three-phase alternator designed for the supply of alternating current of 2,600 volts to a three-phase enclosed synchronous propelling motor, developing 7,000 s.h.p., with a propeller speed of 120 r.p.m. and giving a ship speed of 17 knots.

Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, have launched the "Dalfram," which they have built for the United Steam Navigation Company, Limited, Newcastle-upon-Tyne. The vessel is 450 ft. long, 53 ft. 10 in. broad and 35 ft. deep, and has a deadweight tonnage of 8,450. The "Dalfram" is a sister ship to the "Dalcross" and "Dalcroy" recently completed by Messrs. Scotts for the same owners.

Messrs. Henry Robb, Limited, Leith, launched the twin-screw tug "S. Paulo," built for the Copanhia Docas, Santo, Brazil. The vessel is fitted with fire and salvage pumps, and the propelling machinery consists of two sets of surface condensing engines capable of developing 1,200 i.h.p., constructed by Messrs. MacColl & Pollock, Limited, Sunderland. Steam will be supplied by two oil-fired boilers.

Iron and Steel Industry for Persia.—In 1928 the Persian Government announced its intention to erect a blast-furnace plant near Teheran. In reply to numerous queries recently received the Persian Ministry for Public Works now states that nothing further will be done in this matter until the construction of the railway across Persia has been completed.

THE BRACKELSBERG PROCESS

FOR THE PRODUCTION OF GREY IRON MALLEABLE CASTINGS & METAL ALLOYS.

COVERED BY A SERIES OF PATENTS IN ALL PRINCIPAL COUNTRIES.

ROTARY & TIPPING
PULVERISED FUEL
MELTING FURNACES.

ABSOLUTE CONTROL THROUGHOUT—
LOWEST MELTING COSTS—HIGHEST
EFFICIENCY—HIGHEST QUALITY.

THE BRACKELSBERG MELTING PROCESSES LIMITED,
MALAYA HOUSE · ADMIRALTY ARCH
LONDON · S · W · 1

Telephone :— GERRARD 1313.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863.

JAS. DURRANS & SONS, LTD.

PHŒNIX WORKS, PENISTONE, near SHEFFIELD.

Telephone:
21 PENISTONE.

Telegrams:
"DURRANS, PENISTONE."

FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	68	0	0
Three months	67	7	6
Electrolytic	83	10	0
Tough	74	5	0
Best selected	74	15	0
Sheets	110	0	0
India	91	0	0
Wire bars	83	15	0
Do. April	83	15	0
Do. May	83	15	0
Ingot bars	83	15	0
H.C. wire rods	85	15	0
Off. av. cash, March	69	5	10½
Do., 3 mths., March	67	13	2 13/16
Do., Sttlmnt., March	69	5	11¾
Do., Electro, March	83	16	6½
Do., B.S., March	76	11	3
Do., wire bars, March	84	5	0
Aver. spot price, copper, Mar.	69	5	10½
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11¼d.

BRASS.

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	12¼d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10⅞d.
Wire	10½d.
Rolled metal	10½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	165	15	0
Three months	167	12	6
English	166	15	0
Bars	166	15	0
Straits	165	17	6
Australian	164	17	6
Eastern	167	10	0
Banca	167	12	6
Off. av. cash, March	164	19	0½
Do., 3 mths, March	167	0	2½
Do., Sttlmt., March	164	19	2
Aver. spot, March	164	19	0½

SPELTER.

	£	s.	d.
Ordinary	18	3	9
Remelted	17	10	0
Hard	15	10	0
Electro 99.9	20	12	6
English	18	15	0
India	16	10	0
Zinc dust	25	10	0
Zinc ashes	5	0	0
Off. aver., March	18	11	1½
Aver., spot, March	18	6	0⅞

LEAD.

	£	s.	d.
Soft foreign ppt.	18	7	6
English	19	15	0
Off. average, March	18	17	5 9/16
Average spot, March	18	16	1⅝

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	28	0	0
Do. V.M. ex-whf.	26	10	0
Rods	30	0	0
Boiler plates	24	10	0
Battery plates	25	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	0	0
Chinese	29	10	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	18	6
45/50%	11	10	0
75%	19	12	6
Ferro-vanadium—			
35/50%	12/9 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	£31	0	0
4/6% car.	£23	7	6
6/8% car.	£22	12	6
8/10% car.	£22	7	6
Ferro-chrome—			
Max. 2% car.	£33	15	0
Max. 1% car.	£38	12	6
Max. 0.70% car.	£40	10	0
70% carbon-free	11d. lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£12	10	0
76/80% packed	£13	10	0
76/80% export	£12	15	0
Metallic manganese—			
94/96%, carbonless	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	2
Finished bars, 18% tungsten	£0	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	4	0	to	3	5	0
Bundled steel and shrngs.	2	19	0	to	3	3	0
Mixed iron and steel	2	17	6	to	3	0	0
Heavy cast iron	2	18	0	to	2	19	0
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	0	0
Steel turnings					2	12	6
Cast-iron borings					2	8	0
Heavy forge					3	14	6
W.I. piling scrap					3	10	0
Cast-iron scrap	3	1	0	to	3	4	0
Midlands—							
Ord. cast-iron scrap					3	3	6
Heavy wrought					3	15	0
Steel turnings					1	17	6
Scotland—							
Heavy steel					3	5	0
Cast-iron borings					2	10	0
Wrought-iron piling					3	18	0
Heavy machinery					3	8	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	65	0	0
Brass	42	0	0
Lead (less usual draft)	16	10	0
Tea lead	12	10	0
Zinc	11	0	0
New aluminium cuttings	64	0	0
Braziery copper	60	0	0
Gunmetal	54	0	0
Hollow pewter	120	0	0
Shaped black pewter	87	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	75/6
Hematite M/Nos.	75/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/6
„ d/d Birm.	93/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	74/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	71/-
„ fdry. No. 3*	75/-
Derbyshire forge*	74/6
„ fdry. No. 3*	78/6
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	80/6
„ No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	68/6
„ fdry. No. 3	72/6
Lincs. forge.	71/-
„ fdry No. 3	75/-
E.C. hematite	89/-
W.C. hematite	90/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	73/-
„ fdry. No. 3	77/-
Staffs foundry No. 3	77/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)					10	15	0
Nut and bolt iron	9	0	0	to	9	7	6
Hoops	10	15	0	to	11	5	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to	11	5	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	17	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	2	6

and upwards

Flats—8 in. wide and over	8	12	6				
„ under 8 in. and over 5 in.	8	17	6				
Rails, heavy					8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	15	0
Black sheets, 24 g.					9	15	0
Galv.cor.shts., 24g.	11	17	6	to	12	0	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	6	2	6	to	6	12	6
Billets, hard	7	10	0	to	8	0	0
Sheet bars	5	15	0	to	6	5	0
Tin bars	5	15	0	to	6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/3½
Sheet to 10 w.g.	1/4½
Wire	1/6
Rods	1/5
Tubes	1/9¼
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	33.00
Sheet bars	33.00
Wire rods	38.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.30
Sheets, blue an'l'd, No. 13	2.25
Wire nails	2.25
Plain wire	2.40
Barbed wire, galv.	2.95
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6 to 30/-
„ furnace	17/6 to 22/6
Durham and Northumberland—	
„ foundry	15/6
„ furnace	17/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/3
„	28×20 „	37/-
„	20×10 „	26/6
„	18¾×14 „	19/3
C.W.	20×14 „	16/-
„	28×20 „	34/3
„	20×10 „	23/6
„	18¾×14 „	17/-
Terneplates	28×20	32.6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-Iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water ..	61½%	42½%
Steam ..	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
April	3 ..	70 2 6	inc. 3/9
,,	4 ..	69 16 3	dec. 6/3
,,	7 ..	69 0 0	,, 16/3
,,	8 ..	69 5 0	inc. 5/–
,,	..	68 0 0	dec. 25/–

Electrolytic Copper.

		£ s. d.	
April	3 ..	83 10 0	No change
,,	4 ..	83 10 0	,, ,,
,,	7 ..	83 10 0	,, ,,
,,	8 ..	83 10 0	,, ,,
,,	9 ..	83 10 0	,, ,,

Standard Tin (cash).

		£ s. d.	
April	3 ..	164 10 0	dec. 12/6
,,	4 ..	163 7 6	,, 22/6
,,	7 ..	162 5 0	,, 22/6
,,	8 ..	163 12 6	inc. 27/6
,,	9 ..	165 15 0	,, 42/6

Tin (English ingots).

		£ s. d.	
April	3 ..	165 10 0	dec. 15/–
,,	4 ..	164 10 0	,, 20/–
,,	7 ..	163 5 0	,, 25/–
,,	8 ..	164 15 0	inc 30/–
,,	9 ..	166 15 0	,, 40/–

Zinc Sheets (English).

		£ s. d.	
April	3 ..	28 0 0	No change
,,	4 ..	28 0 0	,, ,,
,,	7 ..	28 0 0	,, ,,
,,	8 ..	28 0 0	,, ,,
,,	9 ..	28 0 0	,, ,,

Spelter (ordinary).

		£ s. d.	
April	3 ..	18 5 0	dec. 2/6
,,	4 ..	18 6 3	inc. 1/3
,,	7 ..	18 6 3	No change
,,	8 ..	18 6 3	,, ,,
,,	9 ..	18 3 9	dec. 2/6

Lead (English).

		£ s. d.	
April	3 ..	20 10 0	No change
,,	4 ..	20 5 0	dec. 5/–
,,	7 ..	19 15 0	,, 10/–
,,	8 ..	19 15 0	No change
,,	9 ..	19 15 0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	5 15 0	5 15 0	5 12 6	5 12 6	5 15 0	5 17 6	5 15 0	5 17 6	6 0 0	6 0 0	6 2 6	6 0 0	5 16 10½
1896	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

LIMPET

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN requires situation. Good practical moulder; age 40.—Box 480, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman required to take charge of Iron and Steel Foundry. One who has had experience in Plate and Machine Moulding in addition to general engineering work. He must be up to date in latest practice and organisation. State age, experience, and wages required.—Manager, Tredomen Works, Ystrad Mynach, near Cardiff.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

Compact and Convenient.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

FACTORY Premises.—Plot of Land and House for sale with vacant possession. Suitable for almost any trade. Accept low price. Owner leaving district.—Apply, Wellings & O'Mara, Earlsfield, S.W.18.

SALES BY TENDER.

WALTHAMSTOW BOROUGH COUNCIL.

SLUDGE PRESSES.

THE Council invite Tenders for six second-hand Sludge Presses, including delivery mains, no longer required at their Sewage Works. Four of these, made by Johnson, Stratford, each consisting of 29 plates, are capable of further use. The total weight of the six presses and mains is approximately 100 tons of cast iron.

The presses may be inspected at the Council's Sewage Farm, Markhouse Road, Walthamstow. Tenders should include the cost of unshipping and clearing away at the contractor's own risk and expense.

Tenders, endorsed "Sludge Presses," should be delivered by post only to the undersigned not later than the 24th instant.

C. SYDNEY WATSON,
Town Clerk.

Town Hall, Walthamstow, E.17.
April 8, 1930.

THE GLASLYN FOUNDRY & ENGINEERING COMPANY, LIMITED, PORTMADOC.

TENDERS are invited for the purchase of the above old-established Foundry and Engineering Works, together with the Plant, Patterns, Machinery, including Modern Electric and Oxy-Acetylene (High-Pressure) Welding Equipment.

The highest or any Tender will not necessarily be accepted.

All particulars to be had from the Liquidator, and all Tenders to be sent to him on or before May 1, 1930, duly sealed and marked "The Glaslyn Foundry," and addressed The Liquidator, Glaslyn Foundry & Engineering Company, Limited, c/o Messrs. Lloyd George & George, Solicitors, 103, High Street, Portmadoc.

MACHINERY.

SAND MIXERS. — New and Secondhand Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

BLOWER, one High-Pressure, by Samuelson, capacity 12,000 cub. ft. of air per min. at 30 in. pressure, guaranteed in condition equal to new, little used, cheap for immediate sale.—Constructional Engineering Company, Limited, Titan Works, Birmingham.

GAS-PRODUCER PLANT, Mond type, by Power Gas Corporation, capacity 18,000 cub. ft. of gas per hr. of 130/140 B.T.U.s per cub. ft., with an anthracite consumption at full load of 2 cwts. per hr.

August Coke-fired MUFFLE FURNACES, for carburising or heat treatment, hearths 6 ft. 6 in. long, 38 in. wide x 26 in. high, by August Muffles, Limited, Halifax.

M.R.V. 440-lbs. MELTING FURNACES, coke-fired, by M.R.V. Furnaces Company, Birmingham.

CRANE COREBOX-MAKING MACHINE.

Oliver No. 77 Pattern-shop Universal BORING MACHINE, with foot-controlled motion and horizontal boring attachment.

Sagar Double-Spindle Vertical MOULDING MACHINE, table 4 ft. x 3 ft. 1 in.

David Brown & Sons (Huddersfield), Limited,
Park Gear Works, Huddersfield.

THOS. W. WARD, LTD.

MAYER & SCHMIDT 9 in. x 24 in. Universal Grinder.

NAXOS-UNION 10 in. x 24 in. Universal Precision Reamer Backing-off Grinder.

No. 100 LUMSDEN Surface Grinder, planetary head.

No. 2 LUMSDEN Oscillating Grinder.

HORIZONTAL DOUBLE-GEARED STEAM WINCHES, 4½ in. x 6 in. stroke to 10 in. x 15 in. stroke; suitable for hauling.

1920-make 4-wheel 14-in. LOCOMOTIVES (Hawthorn Leslie); steel firebox, steel tubes; 160 lbs. w.p.

One 20-n.h.p. PORTABLE STEAM ENGINE AND BOILER.

FOUNDRY LADLES, various types and sizes.

New PRESSED STEEL SECTIONAL TANKS, plates 4 ft. 0 in. or 1 metre square. All capacities, easy to erect.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—King's Patent Agency, Limited, 146A, Queen Victoria Street, E.C.4.

MISCELLANEOUS.

STRAW Ropes and Wood-Wool Ropes for cores and packing purposes. Lowest prices. Best quality. Reliable service. For further information see our half-page advertisement, this Journal, adv. page 18, of March 20.—William Olsen, Limited, Cogan Street, Hull.

"PURIC" CUPOLA FLUX in Block Form cleanses and desulphurises all cupola mixtures. No increase in cost of mixtures, but actual saving obtained, owing to the production of better metal and owing to less wear on the furnace linings.

Over 600 foundries have testified to the advantage of using "Puric." Send for trial cwt.—Write, Beecroft & Partners, Limited, The Foundry Chemists, Retort Works, Mappin Street, Sheffield.

Foundry Consultants and Advisors. Analyses and Testing carried out at low rates at The Laboratories, St. Peter's Close, Sheffield.

MISCELLANEOUS—*Continued.*

GANISTER, best quality for cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton.

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—Furmston & Lawlor, Letchworth.

LINSEED OIL.—30 barrels of Raw Linseed Oil, suitable for foundry use, available for immediate disposal at the price of 10 per cent. below current market values.—Write, Box 474, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FLUORSPAR. — The Ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from

A. BECK,
MINEOWNER, MATLOCK.

NON-FERROUS CASTINGS. — Inquiries solicited from the Trade. Prompt attention; first-class products; reasonable prices.—Precision Castings, Limited, Lincoln Street, Wolverhampton.

PUBLICATION.

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1930 edition now ready. Order your copy now. Price 42s., bound in cloth.—Industrial Newspapers, Ltd., 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

MOULDING MACHINES

Two Britannia head ram machines	£24 each
Two No. 1 Britannia jar ram machines	£38 each
One 48" × 24" Darling & Sellars turnover	£28 (new)
One 24" × 20" Jackman hand turnover	£18

SAND PLANT

One "Jackman" ball-bearing sandmixer	£16
Two "Macdonald" electric gyratory sifters	£11 each
Two "Macdonald" pneumatic sifters	£11 each
Two 6 feet overdriven sandmills	£40 each

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

BUY FROM ME AND SAVE MONEY

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

LOW MOOR FOUNDRY COKE

GUARANTEED ANALYSES.

Sulphur	0·37 ...	0·50
Volatile	0·99 ...	1·30
Ash...	6·34 ...	8·00
Moisture	0·75 ...	1·00
Fixed Carbon ...	91·55 ...	89·20
	100·00	100·00

APPROXIMATE MAXIMUM COMPRESSIVE STRENGTH 3000 lbs.

PHOSPHORUS under 0·04%

CERTIFIED SUITABLE FOR MALTING.

LOW MOOR CLINKERLESS DOMESTIC COKE BURNS CONTINUOUSLY.

MADE FROM THE ORIGINAL AND BLENDED LOW MOOR COALS.

THE LOW MOOR COKE Co., Ltd.,
Low Moor, BRADFORD.

	London:	*Low Moor:*
Telephones:	3096 Victoria	365 Low Moor.
Telegrams & Cables:	"Withstood Phone London"	"Low Moor 365."